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Soil Survey
of
Butler County, Ohio

By

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and
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Ohio Agricultural Experiment Station

Bureau of Chemistry and Soils

In Cooperation with the Ohio Agricultural Experiment Station

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SOIL SURVEY OF BUTLER COUNTY, OHIO

By EARL D. FOWLER, United States Department of Agriculture, in Charge, and T. C. GREEN, Ohio Agricultural Experiment Station

COUNTY SURVEYED

Butler County is in the southwestern part of Ohio in the second tier of counties north of Ohio River. The Indiana State line forms the western boundary. The total area is 466 square miles, or 298,240 acres.

The land in the county is predominantly rolling. Dissection by Miami River and its tributaries has resulted in two distinct types of surface configuration, one the upland or interstream areas and the other the valley bottoms along the streams. Most of the interstream areas have been so invaded by small drainage ways that only a few comparatively level sections remain. The largest two of these more level areas are in opposite corners of the county, one in the extreme northwest corner near College Corner and the other in the southeast corner, east of Maud, along the county line. They occupy the higher divides and range from 1 to 4 miles in width. Parts of them are flat, but for the most part they are very gently undulating, with low knolls rising above the general level. The outer borders become more rolling as the heads of invading streams are approached.

FIGURE 1.—Sketch map showing location of Butler County, Ohio

The slopes in the greater part of the uplands are moderate and not too steep for agricultural purposes, but steeply rolling or rough areas have developed along the valley of Miami River southwest of Hamilton and along Indian, Talawanda, and Sevenmile Creeks, northwest of Hamilton. Northwest of Middletown, between the points where Elk Creek and Browns Run enter the Miami Valley, the surface is broken. Many of the slopes in these rougher sections are subject to destructive erosion, except where they are protected by trees, grass, or some firm covering. The slopes range from vertical bluffs of rock outcrop to long, more gradual slopes rising to an elevation of 200 or more feet above the valleys. Most of the valley walls have a slope between 10° and 20°.

The valley bottoms include the stream flood plains and the terraces, or benches, which roughly parallel the flood plains. They are characteristically flat or nearly flat, except where channels, sloughs, potholes, or the steep faces of the benches occur. As a rule the old sloughs, channels, and potholes are more numerous on the flood plains than on the terraces, or second bottoms.

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The valley of Miami River averages about 2 miles in width through the entire county but broadens out at the entrance of tributary valleys north of Hamilton. This part of the valley is known as Hickory Flats and is highly prized agricultural land. Narrower bottoms along the smaller streams afford a considerable acreage of desirable agricultural land.

The valley of Mill Creek southeast of Hamilton and that of Dicks Creek southeast of Middletown are very striking because of their size in comparison with the size of the streams flowing through them. Apparently they were abandoned valleys which have been invaded by streams along which narrow flood plains have now developed.

The highest recorded elevation in the county, 2½ miles southwest of Oxford, is 1,033 feet above sea level.[1] The lowest is 550 feet, at the place where Miami River leaves the county.

Natural surface drainage is good except on a few comparatively small upland flats. Internal drainage, however, is inadequate in many places, owing primarily to the heaviness of the subsoil layers.

The master stream of the main drainage system is Miami River, which flows diagonally across the county from northeast to southwest. The uplands abound in springs of clear water. The streams from the northwest flow rather swiftly, and a few places in their valleys are favorable for dam sites for power development. The Miami and Erie Canal passes through the county, and though it was abandoned for transportation a number of years ago it affords water supply for a number of shops and mills along its route.

A number of destructive floods have occurred in Miami River Valley, notably in 1805, 1866, and 1913. Since 1913 large dams have been constructed in the Miami drainage system to control the flood water in this part of the State and prevent, if possible, the recurrence of such floods.

In 1680 La Salle, the French explorer, passed down Miami River and was probably the first white man to enter this region. Settlement began in earnest after the signing of the treaty of Greenville in 1795, following the defeat of the combined forces of the Indians by General Wayne. This territory was well populated before the county was organized in 1803, many of the early settlers coming from Kentucky and Virginia. Much later a number of people of German descent settled here. The present boundaries of the county were established in 1815.

The rural and urban population were about equal in 1890, but since that time the urban population has gradually increased over the rural until in 1920 it had reached 72.7 per cent of the total, which in that year was 87,025. The density of the rural population was 52.6 persons to the square mile. Hamilton, the county seat, is the largest city. In 1920 it had a population of 39,675.[2] Middletown is the second largest city. These two cities are progressive industrial centers, producing a great variety of steel, wood, and paper products, and are good markets for agricultural products. Cincinnati to the south and Dayton to the north also provide excellent markets and

[1] U. S. Geological Survey topographic sheet of the Hamilton quadrangle.

[2] Unless otherwise stated, statistics quoted in this report are from United States census reports.

receive most of the surplus products of the county. A number of smaller towns serve as local trading points.

Butler County is excellently served by railroads and highways. The principal railroads are the Chesapeake & Ohio, the Cincinnati, Indianapolis & Western, the Pennsylvania, the Baltimore & Ohio, and the Cincinnati-Columbus division of the Cleveland, Cincinnati, Chicago & St. Louis. In addition to these a branch of the Cincinnati, Lebanon & Northern Railway enters Middletown from the southeast, and trains of the Erie Railroad run over the Baltimore & Ohio tracks through the county. The Ohio Electric from Cincinnati to Dayton passes through Hamilton and Middletown.

The Dixie Highway (United States Highway No. 25), United States Highway No. 27, and a number of well-paved State and county roads, together with good graveled county roads, serve all parts of the county. A progressive program of maintenance of all roads and gradual extension of paved roads is being carried out in the county.

Electric power and light, telephones, and radios are common in many of the rural districts.

CLIMATE

The climate of Butler County is favorable for a diversity of agricultural pursuits. Weather records over a period of 50 years show the average frost-free season to be 172 days at Jacksonburg, between April 28 and October 17. Killing frosts have been recorded at this place as late and early, respectively, as May 21 and September 23. At Hamilton the average date of the latest killing frost is April 21 and the latest recorded was on May 11; the average date of the earliest frost is October 17 and the earliest recorded was on September 25. Early fruits, garden crops, tobacco, and corn are occasionally damaged by frost. Rainfall is well distributed, being heaviest in summer and lightest in fall. Winter temperatures range widely. Moderate temperatures at intervals during the late fall and winter allow a great deal of plowing to be done at this season.

Tables 1 and 2 give the important climatic data compiled from Weather Bureau records for Jacksonburg from 1869 to 1911, inclusive, and for Hamilton from 1911 to 1926, inclusive.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Jacksonburg, Ohio*

[Elevation, 975 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1894)	Total amount for the wettest year (1880)	Snow, average depth
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December	31.5	68	−11	2.97	2.45	3.55	6.7
January	27.8	75	−28	3.62	1.45	5.75	9.7
February	29.5	68	−22	3.27	4.35	2.95	7.4
Winter	29.6	75	−28	9.86	8.25	12.25	23.8
March	39.5	86	0	3.74	1.70	4.55	6.0
April	51.3	89	20	3.13	1.15	6.35	.9
May	62.3	99	29	3.70	2.70	3.65	.2
Spring	51.0	99	0	10.57	5.55	14.55	7.1
June	71.6	101	40	4.07	2.65	8.35	.0
July	75.9	109	49	3.44	.10	3.00	.0
August	74.4	104	44	3.41	.75	4.70	.0
Summer	74.0	109	40	10.92	3.50	16.05	.0
September	68.4	105	32	2.64	2.60	3.45	.0
October	55.7	95	21	2.44	1.00	3.30	(1)
November	41.5	78	−1	3.05	1.00	4.60	1.2
Fall	55.2	105	−1	8.13	4.60	11.35	1.2
Year	52.4	109	−28	39.48	21.90	54.20	32.1

[1] Trace.

TABLE 2.—*Normal monthly, seasonal, and annual temperature and precipitation at Hamilton, Ohio*

[Elevation, 585 feet]

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1914)	Total amount for the wettest year (1913)
	°F.	°F.	°F.	Inches	Inches	Inches
December	31.6	66	−18	2.75	2.83	0.79
January	29.5	64	−20	3.91	2.30	7.82
February	32.6	70	−10	1.95	4.31	1.71
Winter	31.2	70	−20	8.61	9.44	10.32
March	41.3	82	7	4.48	2.48	9.20
April	52.9	91	20	3.70	2.90	5.50
May	63.2	95	32	3.93	1.52	4.07
Spring	52.5	95	7	12.11	6.90	18.77
June	73.4	101	42	3.65	2.67	3.00
July	76.2	106	49	3.45	2.97	4.13
August	73.7	103	39	4.42	7.44	3.13
Summer	74.4	106	39	11.52	13.08	10.26
September	67.1	96	35	3.02	.73	1.66
October	56.5	88	24	2.93	3.51	2.70
November	43.6	78	10	2.65	1.18	2.69
Fall	55.7	96	10	8.60	5.42	7.05
Year	53.5	106	−20	40.84	34.84	46.40

AGRICULTURE

The agriculture of Butler County had its beginning in the attempts of early settlers to establish homes even before the Indians of the region were subdued. Clearings were made, cabins built, and small patches placed under cultivation.

Practically all the virgin timber has been cut, though a few acres are still standing in Oxford Township and in the rolling section northwest of Venice.

Corn has been the principal crop from the time of earliest settlement. Census records show that in 1879 the total production of corn had reached 3,190,457 bushels, with an average yield of 42.5 bushels to the acre. The total acreage devoted annually to this crop has fluctuated slightly, but the average yield in census years has been remarkably uniform.

Wheat very early gained an important place in the agriculture of the county. This crop reached its maximum production of 1,067,969 bushels in 1919, when the average yield was 18.1 bushels to the acre.

Other cereals of importance in the early agriculture of the county were barley, rye, and buckwheat. Of these crops, rye alone has steadily increased in importance to the present time. The production of barley has fluctuated considerably. In 1879 buckwheat had reached a total yield of 2,117 bushels, but it has steadily decreased in importance since that date. Flax also was imported in the early agriculture. The production of 10,765 bushels of flaxseed in 1879 has not been equaled since that date, and the crop has not been reported by the census since 1899.

The special crops of most importance in the early agriculture, named in the order of their importance, were tobacco, potatoes, sweetpotatoes, and broomcorn. Tobacco reached a maximum production of 1,481,102 pounds in 1909. Since then the acreage devoted to this crop has declined steadily. The largest total yield of potatoes reported was 222,540 bushels, obtained in 1889. An average yield of 105 bushels to the acre in 1924 is the highest recorded during the last six census periods.

Hay crops have consisted chiefly of clover, timothy, alfalfa, and millet. Of these crops, only alfalfa has made a steady increase in total acreage. In recent years sweetclover and soybeans have been introduced and are gaining in popularity.

The value of fruits, vegetables, livestock, and livestock products has shown steady progress.

The average size of farms has changed little since 1880, ranging from 111 acres in that year to 107.4 acres in 1920. The rural population and the percentage of farms operated by owners have remained comparatively uniform.

The value of farm property increased from $5,730 a farm in 1900 to $12,766 a farm in 1925. The greater part of this increase is accounted for by the increase in average land values from $57.90 an acre in 1910 to $70.21 in 1925. The percentage of the total value of farm property to the farm represented by land, buildings, implements, and domestic animals, respectively, has remained approximately the same. However, with increased production and increase in the number of livestock, farm operating expenses have rapidly increased.

Agriculture at the present time consists chiefly of general farming combined with livestock raising. The principal general-farm crops are corn, wheat, clover, timothy, alfalfa, and oats, named in the order of their importance. The livestock consists mainly of cattle, hogs, poultry, sheep, horses, and mules.

Wheat is grown principally as a cash crop. More than 85 per cent of the entire crop is of the Trumbull variety. Average yields for the county are about 16 bushels to the acre, but the range is from 10 to 40 bushels. Tobacco, potatoes, and sweet corn are minor cash crops, and melons, tomatoes, and vegetables are grown to a small extent.

Approximately 85 per cent of the corn crop is fed direct to livestock on the farms, only a small proportion being used for silage or sold for cash. Of the 58,074 acres grown in 1924, 3,145 acres were cut for silage. The crop is grown in all parts of the county, though the broad first and second bottoms are especially desirable for corn, and yields ranging from 80 to 115 bushels to the acre have been obtained. The yields over most of the uplands range from 30 to 80 bushels. Yellow dent corn is most generally grown on the uplands and Johnson County White on the bottoms.

Practically all the hay and oats grown are fed on the farms. In 1924, 30,050 tons of hay, chiefly timothy, clover, and alfalfa, were produced. Red and mammoth clover and white sweetclover are the predominating varieties, but alsike, crimson, and Japan clovers are grown on small acreages. Red clover is grown in all parts of the county and is readily established on all except the very poorly drained and decidedly acid soils. The acreage devoted to alfalfa has more than tripled since 1924, now being about 12,000 acres. Northwestern Common is the favorite variety. Soybeans serve principally as a catch hay crop when other hay crops are light. Manchu is the favorite variety.

The 1925 census reports a total of 36,796 hogs in the county. A few farmers feed large numbers annually, but on most farms a comparatively small number is kept. The favorite breeds are Duroc-Jersey, Poland China, Chester White, and Hampshire. Cincinnati is an important livestock market.

Dairy cattle are kept on most farms. Of the 20,088 head of cattle recorded in 1925, 12,925 were dairy cows 2 years old or older and only 1,058 were beef cattle of corresponding age. A total of 4,160,032 gallons of whole milk and 24,168 gallons of cream were sold in 1924. The principal markets are Hamilton, Middletown, and Cincinnati. Holstein and Jersey are the favorite dairy breeds. The 1925 census reported 8,415 head of sheep, but the number has increased recently. Work animals consist of both horses and mules, horses predominating. In 1925 there were 7,116 horses and only 945 mules.

There are only a few specialized poultry farms in the county, most of the poultry being raised as farm flocks. The 1925 census reported a total of 326,495 chickens raised and an egg production of 1,097,691 dozen in 1924, with a total value of $630,865.

Tobacco is grown as a cash crop in certain areas. Most of the tobacco is grown on the second-bottom land in the northeast part of the county. The Seedleaf variety is the favorite, but Spanish Broadleaf and Big Burley are grown to a small extent on the better-drained uplands. Records for 1924 give a total acreage of 563 and an average

acre yield of 757 pounds. Dayton, Middletown, and Germantown are the principal tobacco markets. At present there is a general trend toward reduction of the acreage devoted to tobacco.

In the vicinities of Hamilton and Venice a few farmers grow potatoes as a cash crop. Early Ohio is the principal variety. In 1924 1,217 acres of potatoes were grown, and in the same year 531 acres of sweet corn. A cannery at Oakland, in Lemon Township, cans part of the corn, but the greater part is sold fresh at near-by markets. This crop is grown largely on valley land. The acreage devoted to cantaloupes and watermelons is rapidly increasing, as the market demand is encouraging. Other crops commonly grown on a small total acreage, mainly for home use but to some extent for sale, include cabbage, tomatoes, lettuce, onions, beans, peas, beets, radishes, carrots, cauliflower, pumpkin, squash, rhubarb, strawberries, raspberries, gooseberries, and currants.

Of the orchard fruits, apples and peaches are the most important. In 1924 a total production of 7,123 bushels of apples and 1,319 bushels of peaches was reported. Pears, plums, grapes, and cherries are grown for home use on many farms.

The prevailing type of agriculture is much the same over the county, regardless of the kind of soil or surface features. Any variations are largely from necessity. For example, in places the continued cultivation of steep slopes has resulted in such serious erosion that the type of agriculture must be changed or the areas entirely abandoned. Difficulty in establishing a stand of clover on certain soils has resulted in a change to soybeans. As a rule, however, the combination of general farming and livestock raising, together with the production of a few special crops, is admirably suited for an efficient utilization of the various kinds of soils occurring on most farms.

Adaptation of soils to crops is not generally considered, but recognition of the need of such study is becoming more general. However, the bottom soils have long been recognized as especially suited to corn. Alfalfa is grown chiefly on the better-drained first-bottom and terrace soils and on the well-drained Russell silt loam in the uplands. Potatoes are grown commercially mainly on Fox silt loam. Brookston silt loam is recognized as particularly suited to the production of corn and clover, but owing to its small extent and its occurrence in comparatively small patches a distinct type of agriculture has not developed on it.

In general, cultural practices are good. Wheat usually follows corn in the rotation. Oats are planted in the spring, often following corn. Clover or clover and timothy is usually sown in the wheat in the early spring, though sweetclover is sometimes sown in the corn following the last cultivation. For tobacco, a very thorough preparation of the land is made. Root rot, tobacco worm, and rust must be fought in producing tobacco in this region.

A 3-year rotation of corn, wheat, and clover is general, though oats are sometimes substituted for wheat. When tobacco is grown, the common rotation is tobacco, wheat, and alfalfa. The alfalfa is left about three years. After potatoes, wheat and then clover are grown. With sweet corn, a common rotation is corn two years and alfalfa two years. On the fertile bottom lands corn succeeds itself in some fields for a number of years.

The 1925 census records a total of $72,765 expended for fertilizers, including lime, in 1924, on the 856 farms reporting. This is an average of $85 a farm. Wheat receives more fertilizer than any other crop. From 100 to 150 pounds of a 4–24–4 grade or from 100 to 200 pounds of a 2–12–2 fertilizer to the acre is commonly applied at seeding time. Superphosphate is used less commonly. Corn is not usually fertilized, but at times superphosphate supplements manure. Tobacco is more heavily fertilized, generally receiving about 200 pounds of superphosphate in addition to 7 or 8 loads of manure to the acre. Barnyard manure is carefully utilized, principally as a top-dressing on clover or grass land. The practice of using superphosphate along with the manure is becoming more common, and the results are, in general, very satisfactory. Most of the liming has been done in Oxford Township. In 1927, one lime-material company sold 697 tons of finely ground limestone in the county. Sweetclover is commonly plowed under as a green-manure crop, and rye is also used to a very small extent for this purpose.

Many of the farms in the county are well equipped. Houses, barns, and fences are well constructed and kept in good repair. Silos were reported on 312 farms in 1925. Tractors are in general use as supplementary power for plowing and cultivating crops and for pulling grain binders. The 1925 census reports 537 tractors in the county.

Farm laborers are mainly native whites. In general, there is a shortage of labor on the farms, but this is being compensated for in urgent cases by a more efficient utilization of power and labor-saving machinery.

In 1925 there were 2,457 farms in the county. The average size was 112.8 acres. Of the 2,457 farms reported, owners were operating 1,447, part owners 141, managers 16, and tenants 853. The percentage of tenancy has decreased from 41 per cent in 1910 to 34.7 per cent in 1925. Most of the tenants operate on the share system under contract for periods ranging from one to five years. Comparatively few farms are rented for cash.

Certain soils or groups of soils are of outstanding value when considered only on the basis of their productive capacity over a period of years, without regard to their location with respect to markets or their total extent. On this basis, Genesee silt loam, Genesee fine sandy loam, and Ross silt loam rank among the first. These soils, however, are subject to occasional floods. Fox silt loam, with its deep and dark-colored phases, the deep phase of Warsaw silt loam, Warsaw loam, Montgomery silty clay loam, Brookston silt loam, and Clyde silty clay loam are considered among the most valuable soils for crop production. Following these in productivity are Russell silt loam, with its eroded phase, Bellefontaine silt loam, Fox fine sandy loam, Fox sandy loam, and Eel silty clay loam. Next in order are Fincastle silt loam, Miami silt loam, McGary silt loam, with its gravelly substratum phase, and Westland loam. In the fourth group are Fox gravelly loam, with its dark-colored phase, Shandon fine sandy loam, Bellefontaine fine sandy loam, Genesee sandy loam, and Cincinnati silt loam. With the exception of Cincinnati silt loam, the soils of this group vary in productivity from place to place and from year to year, because crops are subject to injury at times from drought. The fifth and last group includes Delmar silt loam, Fair-

mount silt loam, Fairmount silty clay loam, Rossmoyne silt loam, Clermont silt loam, and Genesee fine sand. The Fairmount soils are inherently fertile, but are subject to destructive erosion under continued cultivation.

The upland soils of the county having gray, yellow, or brown surface soils are as a rule deficient in available organic material and phosphorus. As these soils comprise a very large proportion of the total acreage devoted to agriculture, the supplying of this deficiency immediately becomes one of the outstanding agricultural problems. Experiments show that the most economical ways to replenish and maintain the supply of organic material of the soil are to apply well-preserved barnyard manure, to return crop residues, and to grow legumes; that the organic matter in the soil contains nearly all the nitrogen and a large proportion of the phosphorus and potassium needed for living plants; and that additional supplies of phosphorus and potassium applied in the form of high-grade fertilizer are not only beneficial but pay a good premium on the investment by an increase in production. Therefore it is apparent that a system of agriculture based on the conservation of manure and crop residues, the growing of green-manure crops, including legumes, as an important part of the rotation, and the application of phosphorus and potassium when needed will meet the needs of most crops on the soils of this county.

The many legumes which may be satisfactorily grown in this region offer a wide range in choice for a particular soil or type of farming. The more important leguminous crops are alfalfa and clover, including sweet, red, mammoth, and to less extent alsike, Japan, and white clover. Soybeans and cowpeas can also be grown. The great areas of soils occupying the first and second bottoms along streams, including soils of the Genesee, Ross, Eel, Fox, Warsaw, and Westland series, are in general admirably suited to alfalfa and many of the clovers. Alfalfa and clover may also be grown in favorable situations on some of the well-drained light-colored upland soils which are so greatly in need of organic material. In this group of soils are members of the Russell, Miami, Bellefontaine, McGary, Shandon, Fincastle, and Fairmount series. The Fincastle soils are not well suited to alfalfa, and in many places poor drainage, acidity, and lack of organic materials and phosphorus become serious hindrances to growing all clovers except alsike. Under present conditions the Delmar, Rossmoyne, and Clermont soils require artificial drainage, liming, and liberal replenishing of phosphorus and potash before clover can be grown satisfactorily. In bringing these soils into better production, soybeans are valuable in the rotation.

The dark-colored soils of the upland, including those of the Brookston, Montgomery, and Clyde series, are well suited to all clovers, and if care is exercised in choosing a rotation the fertility of these soils is readily maintained.[3]

Another outstanding problem in Butler County is the prevention of erosion. The seriousness of this problem may be realized when the total area (76.6 square miles, or about one-sixth of the total area of the county) of the eroded phase of Russell silt loam is noted.

[3] More specific and helpful information regarding the requirements of the various soils may be obtained from the Ohio Agricultural Experiment Station, Wooster, Ohio.

This soil occurs in all parts of the county, and it is a well-known fact that it is increasing in extent each year as the heads of numerous small drainage ways reach farther back into the uplands. There are many comparatively simple methods of retarding the advance of erosion. Terracing cultivated slopes is one method that has proved successful in many places and is used to a small extent in the vicinity of Princeton. Straw, rocks, boards, wire obstructions, and brush may also be used to construct barriers or dams in small gullies in order to catch the soil and gradually fill the ravines. A permanent cover of bluegrass, sweetclover, trees, or other vegetation checks the rapid advance of erosion on the steeper slopes.

SOIL SERIES AND TYPES

The soils occupying the greater part of Butler County are comparatively uniform in their main physical characteristics. They are in general moderately well drained and have light-colored silty surface layers underlain by brownish heavier clayey layers. Below the clayey layers the proportion of clay decreases, and at an average depth of 40 inches a layer of mixed clays, sands, silts, gravel, and scattered bowlders occurs. This layer, containing a fairly high percentage of lime, is composed largely of limestone and shale material. It is the unmodified or only slightly modified parent material. Weathering agencies gradually invade the parent material to greater depths and through such processes as disintegration, decomposition, and leaching form the overlying layers. Soils having these major features in common are mapped chiefly in the Russell and Fincastle series, which together comprise 70 per cent of the total area of the county.

The Russell soils are the most extensive in the county. The silty surface layer is grayish brown and averages about 12 inches in thickness. It is underlain by brown or faintly reddish-brown silty clay loam or silty clay which at a depth of about 30 inches becomes lighter in color and grittier in texture. The parent material lies at a depth ranging from 35 to 60 inches.

The Fincastle soils are also widely distributed. The surface layer is typically grayer than that of the Russell soils, and the heavy layer is definitely mottled with gray, yellow, and brown. Below this the succession of layers is the same as in the Russell soils.

Other soils occupying comparatively well-drained situations in the county are mapped in the Fox, Bellefontaine, Miami, Cincinnati, Rossmoyne, Warsaw, McCary, and Shandon series.

The Fox soils are characterized by brown surface layers underlain by reddish-brown heavier layers resting rather abruptly, at a depth ranging from 1 to 4 feet, on beds of stratified sand and gravel.

The Bellefontaine soils are similar to the Fox in that they have brown surface layers and reddish-brown subsoils which have developed where surface and internal drainage have been good. They are also underlain by gravelly and sandy substrata.

The Miami soils are similar to the Russell in the color, character, and arrangement of the soil layers, but the calcareous parent material occurs nearer the surface, less silt is present in most places in the surface layers, and the change from the heavy layer to the parent material is comparatively abrupt.

The members of the Cincinnati series have brown surface soils, reddish-brown subsurface soils, and mottled yellow, brown, and gray iron-stained clayey subsoils overlying limy loam or clay loam parent material at a depth ranging from 5 to 10 feet. The upper layers are acid in reaction.

The Rossmoyne soils have grayish-brown or brown silty surface layers, yellowish-brown clayey upper subsoil layers, and gray, yellow, and brown lower subsoil layers (below a depth ranging from 14 to 20 inches). At depths of 8 to 12 feet a limy substratum of mixed sand, clay, and scattered gravel is reached.

The soils of the Warsaw series are similar to those of the Fox, with the exception that the surface layers are dark gray or dark brownish gray instead of brown.

The McGary soils have light brownish-gray or yellowish-gray surface layers, brown or dark-brown and gray heavy clayey subsoils, and heavy brown and bluish-gray calcareous clay substrata.

The Shandon soils have brown sandy surface soils and reddish-brown or yellowish-brown sandy and clayey subsoils. The underlying substratum closely resembles that under the McGray soils.

The Delmar and Clermont soils have light-gray surface layers, mottled with yellow, and brown and gray iron-stained subsoils. They are derived from calcareous glacial till of mixed sand, silt, clay, and scattered gravel fragments. The soluble lime has been leached from the Clermont soils to an average depth of 10 feet and from the Delmar to only about 40 inches.

In poorly drained areas, on steep slopes, and in the first bottoms of streams the soil-forming processes have not developed soils normal to the region but have operated incompletely or abnormally, according to local conditions. Soils of the Brookston, Clyde, Montgomery, Fairmount, Genesee, Eel, Ross, and Westland series have such incomplete or abnormal profiles.

The Brookston and Clyde soils are dark-colored imperfectly drained soils. The Clyde are in a saturated condition the greater part of the year. This condition has resulted in the formation of bluish-gray heavy plastic subsoils in the Clyde soils, whereas in the Brookston soils better internal drainage has caused the development of mottled gray and yellowish-brown clayey subsoils. The parent material of members of both series is similar to that of the Russell and Fincastle soils.

The Montgomery soils resemble very closely the Brookston in color and character of the surface and subsoil layers but differ in having a substratum of heavy slack-water clays.

The soils of the Fairmount series have limestone slabs scattered over the surface and through the soil. Bedrock occurs at a depth ranging from 24 to 30 inches in most places. These soils are readily distinguished by their very dark-brown surface layers grading below into lighter-brown and finally into greenish or olive-yellow heavy, plastic, sticky clay lying just above the bedrock.

The Genesee series is represented by the stream flood-plain soils which have brown or grayish-brown surface layers underlain by light-brown, yellowish-brown, gray, or dark-brown layers. Loose, incoherent sandy layers lie within 40 inches of the surface in most places. Most of these soils are well supplied with lime and available plant food.

The Eel soils have brown or dark-brown silty or clayey surface soils grading downward through rather heavy iron-stained materials of gray, brown, and yellow shades. At a depth ranging from 6 to 10 feet a sandy or gravelly substratum is commonly reached.

The Ross soils are dark gray or dark brownish gray to a depth ranging from 18 to 30 inches. The next lower material is brown and sandy. Gray and yellowish-gray loose sand and gravel occur at a depth ranging from 36 to 50 inches.

The Westland soils have brownish-gray or light brownish-gray surface layers overlying mottled gray, yellow, and yellowish-brown material. At an average depth of about 36 inches, gray poorly assorted calcareous gravel and sand occur.

In addition to soils of the series described, river wash, a miscellaneous class of material, is mapped. It consists of such materials as sand, gravel, bowlders, and driftwood and is nonagricultural.

In the following pages of this report the soils of Butler County are described in full and their relation to agriculture is discussed; their distribution is shown on the accompanying soil map; and their acreage and proportionate extent are given in Table 3.

TABLE 3.—*Acreage and proportionate extent of the soils mapped in Butler County, Ohio*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Russell silt loam	109,888	53.2	Ross silt loam	3,008	1.0
Eroded phase	49,024		Eel silty clay loam	1,728	.6
Fincastle silt loam	50,112	16.8	Warsaw loam	896	.3
Delmar silt loam	448	.2	Warsaw silt loam, deep phase	384	.1
Fox silt loam	15,488	5.8	Clyde silty clay loam	320	.1
Deep phase	1,280		Bellefontaine silt loam	640	.2
Dark-colored phase	448		Bellefontaine fine sandy loam	576	.2
Fox gravelly loam	4,288	1.7	Miami silt loam	1,536	.5
Dark-colored phase	896		Cincinnati silt loam	1,088	.4
Fox fine sandy loam	5,056	1.7	Rossmoyne silt loam	128	.1
Fox sandy loam	704	.2	Clermont silt loam	64	.1
Genesee silt loam	19,840	6.6	Fairmount silt loam	4,992	1.7
Genesee fine sandy loam	10,304	3.4	Fairmount silty clay loam	2,688	.9
Genesee sandy loam	384	.1	Shandon fine sandy loam	320	.1
Genesee fine sand	512	.2	Westland loam	704	.2
Brookston silt loam	5,056	1.7	River wash	1,536	.5
Montgomery silty clay loam	2,688	.9			
McGary silt loam	768	.5	Total	298,240	
Gravelly substratum phase	448				

RUSSELL SILT LOAM

Russell silt loam is the predominant soil on the rolling well-drained uplands and is also the most extensive and one of the most widely distributed soils in the county. From the surface downward it shows three layers having different textures and other markedly different features. The upper layer is light grayish-brown [4] or brown smooth silt loam averaging 12 inches in thickness. In forested areas a thin veneer of loose leaves and other vegetable remains is on the surface, and organic matter has colored the first 2 or 3 inches of soil dark gray. Cultivation mixes the organic material with the brown material below. The middle layer, which extends to a depth ranging from 28 to 60 inches and averaging about 40 inches, is moderately plastic and sticky silty clay loam. It grades in color from dark

[4] The color descriptions, unless otherwise specified, refer to the natural colors found under average field moisture conditions.

brown with a reddish hue in the upper part of the layer to predominantly grayish yellow with some penetration of the reddish brown from above. Below this layer is grayish-yellow, yellowish-brown, and gray gravelly loam in which the gray becomes more pronounced with increasing depth. Limestone and dolomite fragments comprise a large proportion of the coarser materials in this layer, and granite, quartzite, diorite, and other very hard rocks form the remainder. These harder fragments are scattered through the soil and on the surface. (Pl. 1, A.)

This soil is not strongly acid. The upper part of the middle layer shows a slightly acid reaction, but the lower part is neutral. The third layer is decidedly limy, and the content of lime increases downward to the practically unaltered bowlder clay or glacial till.

The principal variation included with this soil in mapping has a dark-brown silt loam surface layer from 6 to 10 inches in thickness, overlying layers identical with those in the typical soil. This variation is very inextensive, occurring in three areas, one 4 miles northwest of Middletown, another 1 mile northeast of Sevenmile, and the third 4 miles east and 2 miles north of Oxford. All these areas occur at the foot of long gradual slopes from the near-by limestone hills. Small areas of Fincastle silt loam are included, owing to their small extent or to the gradual transition from one soil to the other. The variation in depth to the limy layer is brought about chiefly by the varying thickness of the lower part of the heavy horizon. The layers above this heavy layer are uniform in thickness over the county, except where erosion hindered their normal development.

Russell silt loam occupies more than 95 per cent of the total area of the best-drained uplands. The typical occurrence is on the rolling lands along the network of drainage ways which head into the upland. In many places in the more thoroughly dissected sections the soil occupies the entire interstream area. Both surface and internal drainage are good.

Approximately 65 per cent of the Russell silt loam is under cultivation. The broken and rougher parts are utilized for pasture and woodland. The tree growth consists chiefly of sugar maple, red oak, black walnut, and tuliptree, with some ash, beech, white oak, and elm. Kentucky bluegrass, the principal pasture grass, grows very luxuriantly.

This is an important agricultural soil and is used principally for general farming, supplemented by dairying. Corn, wheat, clover, and alfalfa are the chief crops, and some tobacco is grown as a cash crop. The Spanish and Dutch varieties of tobacco are grown, as they are best suited to the upland soils. Apples, peaches, pears, plums, cherries, berries, and garden crops such as potatoes, tomatoes, beans, peas, cabbage, and onions give satisfactory yields but are grown only in small quantities for home use. Corn yields from 30 to 60 bushels to the acre, wheat from 15 to 40 bushels, and clover hay from 1 to 1½ tons. Yields of tobacco range from 600 to 1,000 pounds to the acre. Sweetclover, red clover, and alfalfa do well, though injury on the more shallow, less fertile areas is common during open winters.

A 3-year rotation of corn, wheat, and clover is commonly practiced. Most farmers use from 100 to 125 pounds of a 4–24–4 [5] fertilizer, from 100 to 200 pounds of a 2–12–2 grade, or an application of superphos-

[5] Percentages, respectively, of nitrogen, phosphoric acid, and potash.

phate (acid phosphate) on wheat. Clover is sown in the wheat and as a rule is given a light top-dressing of manure. It is not common practice to fertilize corn though some farmers use superphosphate or an application of "half-and-half" (phosphate and potash) for corn on the Russell and Fincastle soils. Tobacco commonly receives an application of 200 pounds of superphosphate to the acre and in addition from 5 to 8 loads of manure.

Russell silt loam, eroded phase.—Russell silt loam, eroded phase, occurs on the valley slopes of most of the streams and small drainage ways in the county where a part and in places all of the upper two soil layers of Russell silt loam has been eroded. On the more gradual slopes the typical profile shows a thin remnant of the grayish-brown silt loam surface layer, underlain by a reddish-brown silty clay layer identical with the heavy layer of the typical soil except that it is thinner, having a maximum thickness of 18 inches. Cultivation mixes the upper two layers, so that the surface soil in plowed fields is reddish-brown silty clay loam. The calcareous parent material is exposed on many of the steeper slopes.

A few small areas at the extreme heads of valleys are cultivated. Forest growth, crops grown, methods, and treatment are similar to those on Russell silt loam, but crop yields generally average less on the eroded phase. The greater part of this soil is used for pasture and forestry. Bluegrass does well if it is not pastured too closely. Most of the steeper slopes are either forested or stand as barren cliffs.

Terracing is practiced in the vicinity of Princeton. In other places straw, tree limbs, and rock barriers have been constructed to check erosion and fill in the small gullies. Damage by erosion is more serious on Russell silt loam, especially on the eroded phase, than on any other soil in the county.

FINCASTLE SILT LOAM

Fincastle silt loam has three main layers, as follows: (1) Floury friable silt loam from 10 to 14 inches in thickness which grades in color from dark grayish brown in the upper 2 or 3 inches to yellowish brown and gray specked with dark-brown iron stains; (2) a sticky plastic silty clay loam layer averaging about 28 inches in thickness and grading from brownish-yellow, yellowish-gray, and dark brownish-gray material in the upper half to predominantly gray gritty silty clay loam in the lower half; and (3) a massive layer of gray, yellow, and brown clay loam glacial till which represents the parent material and extends to a depth of several feet. In an air-dry condition the colors become lighter and the natural lumps or clods into which the material breaks become very hard and difficult to crush under direct pressure though they break readily under a shearing force in the hands.

In forested areas the first layer is only slightly acid or neutral in the upper part and moderately acid in the lower part; the second layer ranges from slightly or strongly acid in the upper half to neutral or slightly alkaline in the lower half; and the third layer is decidedly alkaline, effervescing freely in cold dilute hydrochloric acid.

Iron-oxide concretions (buckshot), to a maximum of one-fourth inch in diameter, are scattered on the surface and through the soil

material. They are most numerous on the more nearly level areas of lighter-colored soil.

The principal variations in this soil are the depth at which the calcareous parent material occurs, difference in the degree of mottling of the heavy layer, and variation in the proportion of sand and gritty material in the lower half of the second layer. Locally the substratum is sandy or loamy, and in such areas leaching of the lime has occurred to a depth of 50 or 60 inches. This is true in many small patches on the comparatively smooth divide northwest of Oxford. The degree of mottling differs with drainage and topographic conditions. The material is more gray on the smoother areas where the soil grades toward Delmar silt loam, and shows more brown and yellow in the more rolling situations where it grades toward Russell silt loam with which it is intimately associated.

Fincastle silt loam is widely distributed, occupying smooth divides or interstream areas. Large areas are northwest of Oxford, west of Hamilton in the vicinity of St. Charles, and east of Hamilton in the vicinity of Bethany.

Surface drainage is fair; but water movement through the heavy layer is slow, as is indicated by the mottling and the presence of iron concretions. Tile drainage has proved beneficial on this soil. Adequate drainage, together with liming, has been found necessary in many places in order to continue the growing of clover.

Approximately 75 per cent of the soil is utilized for general farm crops, and the remainder is in pasture and scattered wood lots. The most common trees are beech, red oak, hickory, and sugar maple; and white oak, papaw, ironwood, dogwood, elm, locust, and black walnut are less common. The principal pasture grass is Kentucky bluegrass, which grows well on this soil.

The crops grown are practically the same as on the Russell soils. Corn yields are slightly less than on Russell silt loam, but wheat yields 25 or more bushels to the acre under favorable conditions. Oats yield from 30 to 50 bushels and clover from 1 to 1½ tons to the acre.

As a rule this soil is in need of lime and is low in available phosphorus and potash. It is also low in nitrogen unless legumes have been grown regularly in the rotation.

DELMAR SILT LOAM

Delmar silt loam is a poorly drained gray soil occurring on upland flats. It is sometimes referred to as "buckshot land," owing to the presence of numerous small dark-colored iron concretions on the surface and through the soil. Typically the 12 or 14 inch surface layer is light-gray floury silt loam specked with yellow and brown iron stains. The forested soil has a surface covering, an inch or two thick, of very dark brownish-gray silt loam, but under cultivation the dark organic coloring disappears rapidly. Below the silt loam surface layer the soil is similar in texture, thickness, and arrangement of layers to Fincastle silt loam, with which it is closely associated. However, the color is markedly grayer, and the yellow and brown mottles and stains are less pronounced than in the Fincastle soil. The calcareous substratum occurs below a depth of 36 or 40 inches.

A moderately strong acid reaction is common in the subsurface and subsoil layers.

This soil is comparatively unimportant in the agriculture of the county. The principal areas are in Milford and Oxford Townships in the northwestern part of the county, and in Union Township in the southeastern part. Two small areas are east and southeast of Sevenmile.

Where this soil has been properly drained and fertilized with a high-grade commercial fertilizer it produces fair yields of excellent quality wheat. Lime is required on most fields before clovers or alfalfa can be grown successfully. Corn yields about 30 bushels or less to the acre. Soybeans grow well and are a desirable legume to plant on areas where clover can not be grown satisfactorily.

The trees of the few remaining forested areas are predominantly beech, with a mixture of ash, elm, red oak, white oak, and sugar maple.

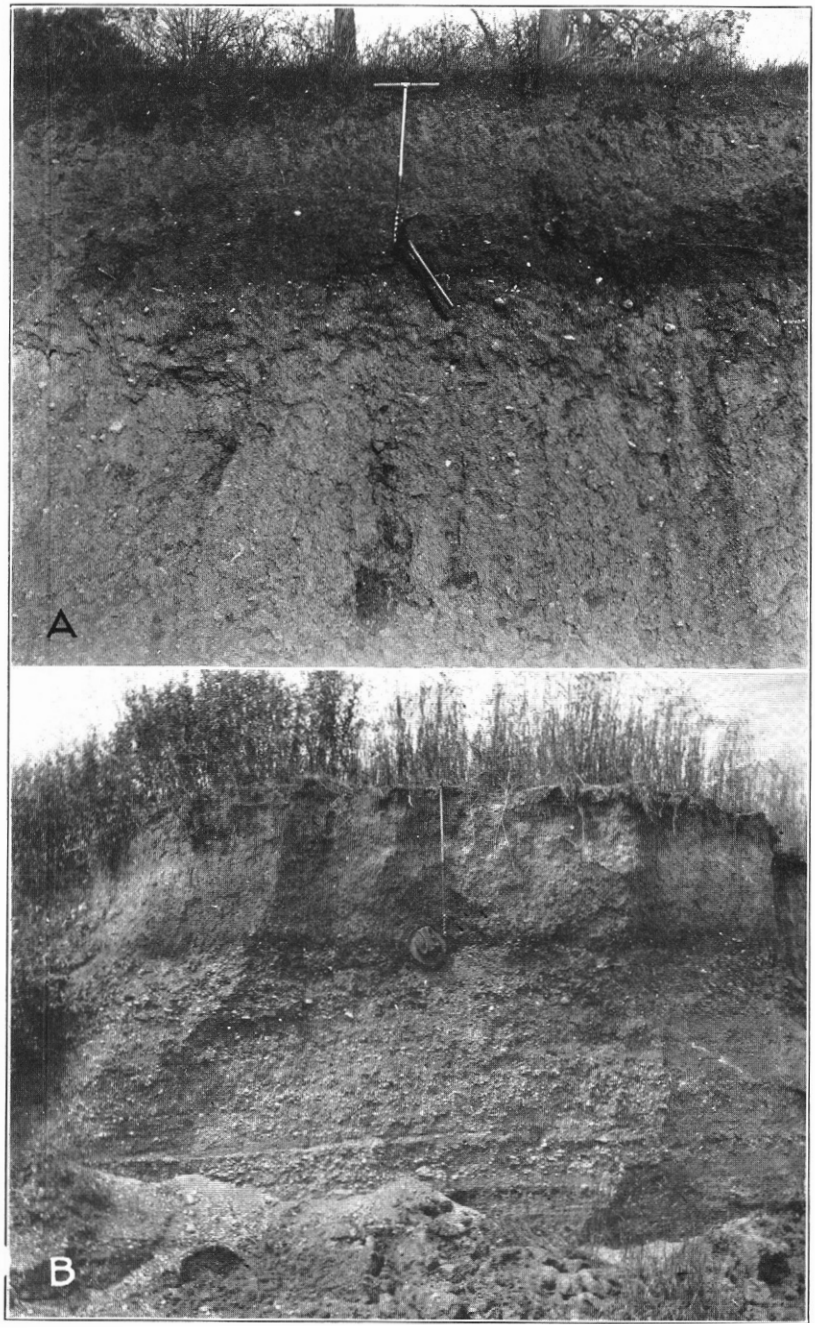
FOX SILT LOAM

Fox silt loam is composed of four rather distinct layers. The surface layer is silt loam, averaging 12 inches in thickness, which grades from grayish brown in the upper 3 inches to brown with a slight tinge of red in the lower part. In forested areas the larger quantity of organic matter present imparts a very dark grayish-brown color to the first 2 or 3 inches. This silty layer is slightly plastic when wet but smooth and friable when dry, and as a rule the lower part is slightly acid. The second layer is brown silty clay loam having a decided reddish cast. It averages about 20 inches in thickness and becomes slightly heavier, stickier, and more gritty in the lower part. The material of the upper half breaks naturally into fragments having angular faces ranging from one-fourth to one-half inch in diameter, whereas that of the lower half breaks into irregular lumps which become very hard when dry. Many small needlelike holes penetrate the lumps at different angles. As a rule this layer is moderately acid, though in places it is neutral in reaction.

Below the heavy layer just described is a definite layer, averaging about 5 inches in thickness, of very dark reddish-brown sticky gravelly clay loam in which the reaction ranges from neutral to alkaline. A concentration of manganese commonly occurs in this layer. The line forming its lower boundary is wavy, as viewed in a cross section, and jagged points or teeth extend down into the layer below to a distance of 2 or 3 feet in places. The fourth layer, which comprises the parent material, consists of loose, stratified, more or less rounded, calcareous sands and gravel occurring at a depth ranging from 36 to 40 inches. The material is chiefly limestone and dolomite, mixed with a small proportion of granite, quartzite, diorite, gneiss, and other hard rock fragments. (Pl. 1, B.)

There is no great variation in this soil, though a slight range in color, texture, and thickness of the layers occurs locally where it grades into the associated Fox and Warsaw soils.

Fox silt loam occurs in Miami River Valley and along other large streams on the high benches or second bottoms which lie from 15 to 50 feet above the streams and are very rarely flooded. The areas are nearly level for the most part, only small rounded depressions



A, Profile of Russell silt loam; B, profile of Fox silt loam

or slightly hummocky patches breaking the otherwise nearly level plains. These large flats are locally termed "hickory flats" or "walnut levels."

Drainage is well established, owing to the presence of the gravel substratum comparatively near the surface. Except where the gravelly layer lies only a few inches below the surface the heavy subsoil prevents excessive loss of moisture through the soil.

Practically all the Fox silt loam is under cultivation. A small acreage is utilized for sites for farmsteads, towns, gravel pits, highways, and railroads. Only a few small areas remain forested with their original sturdy growth of walnut, hickory, sugar maple, and red oak.

The soil is very fertile and highly prized for farming. Corn, wheat, alfalfa, and clover are the principal farm crops grown. Corn commonly yields from 40 to 75 bushels to the acre, wheat from 15 to 30 bushels, and hay from 1½ to 1¾ tons. Wheat generally receives from 100 to 250 pounds to the acre of 2–12–2 or of other fertilizer. This soil is especially desirable for seedleaf tobacco and for potatoes. For tobacco it is given a heavy application of barnyard manure and an average of 175 pounds of superphosphate to the acre. Acre yields of tobacco range from 1,000 to 1,500 pounds. Potatoes also receive a good grade of fertilizer or an application of manure. Yields of potatoes range from 150 to 300 bushels to the acre.

Fox silt loam, deep phase.—The upper layers of Fox silt loam, deep phase, are similar in color, texture, and thickness to those in typical Fox silt loam, but the phase differs in having an abnormally thick layer between the silt loam surface soil and the gravel substratum. Below the brown silt loam surface layer, which averages about 12 inches in thickness, lies a silty clay loam layer averaging about 5 feet in thickness though it ranges from 3 to 12 feet. The first 8 or 10 inches of this layer are brown. When moist the soil material is plastic and the fine particles cling together and break into the angular-faced lumps common in the heavy layers of silty well-drained soils in this region. Below this the material grades into dark-brown or dark reddish-brown heavy silty clay loam extending to a depth of 36 or more inches and showing definite columns from 4 to 6 inches in height which break readily into angular lumps similar to those in the surface layer. Below this the material is light reddish brown and grades from silty clay loam to sandy clay loam which continues to the thin dark reddish-brown layer overlying the stratified sand and gravel. The acidity is considerably higher, particularly in the lower part of the heavy layer, than in typical Fox silt loam. The depth to the gravel layer differs within short distances, and as a rule it decreases as the distance from valley bluffs increases. In places a few areas of typical Fox silt loam and of its dark-colored phase were included in mapping because of their small extent. The deep phase of Fox silt loam occurs in the valley of Miami River west of Trenton and in Indian Creek Valley south of Millville. Areas lie only at the outer border of the valleys. Surface features, drainage, and utilization are practically the same as on the typical soil.

Fox silt loam, dark-colored phase.—To a depth of 6 or 8 inches the surface soil of the dark-colored phase of Fox silt loam consists of

dark grayish-brown silt loam, slightly sticky and appearing a shade darker in color when moist. This layer grades downward into heavy dark-brown silt loam tinged with red, and extends to an average depth of 19 inches. It is underlain by a 12 to 16 inch layer of reddish-brown sticky plastic silty clay loam which becomes gritty in the lower part. A thin layer of very dark reddish-brown, sticky, gravelly clay loam underlying this corresponds to the third layer in typical Fox silt loam. Beds of stratified sand and gravel occur at an average depth of 36 inches. Ordinarily this soil is less acid than the typical soil. Though the intensity of the color differs slightly from place to place, the soil is uniformly darker colored than typical Fox silt loam.

Areas of this dark-colored soil occur on the broad second bottoms of Miami River and Talawanda and Sevenmile Creeks. The land surface is nearly level. Drainage is good and the moisture-holding capacity of the soil is excellent.

This soil is inherently fertile and is highly prized farming land. It is all under cultivation and is well improved. Crops grown are the same as on typical Fox silt loam, and yields average a little more, as a rule. The original forest growth was similar to that on associated soils.

FOX GRAVELLY LOAM

Fox gravelly loam has a dark-brown or brown mealy and friable loamy surface layer averaging 8 inches in thickness. Considerable gravel and coarse sandy material is on the surface and scattered through the soil. These fragments increase in number with depth. The next lower layer is gravelly clay loam about 16 inches thick. The upper half is dark reddish brown and is moderately sticky and plastic when moist, and the lower half is very dark reddish brown and very sticky and plastic. At an average depth of 24 inches the material changes rather abruptly to calcareous gray and yellowish-gray loose stratified gravel and sand. As a rule the soil contains sufficient lime to meet the requirements for most crops.

The color of the surface layer ranges from light grayish brown to the very dark brown of the dark-colored phase of Fox gravelly loam, with which this soil is associated. Small gravel knolls, in some of which the material is loose and incoherent, occur in places. Hamilton is located on one of the largest areas of this soil. Smaller areas occur in Miami Valley south and northeast of Hamilton, and a few small areas are in the valley of Sevenmile Creek. The land surface is level or very gently undulating.

Natural drainage is excellent. Crops on the shallower and more gravelly areas are sometimes damaged during dry periods, owing to excessive aeration in these places. However, over most of the soil during average seasons the heavy subsoil retains moisture remarkably well.

All the Fox gravelly loam is cleared and cultivated, chiefly to general farm crops. Tobacco, potatoes, and garden truck are special crops. The agricultural value of this soil is generally considered as being slightly lower than that of Fox silt loam.

Fox gravelly loam, dark-colored phase.—To a depth of 8 or 10 inches the surface layer of the dark-colored phase of Fox gravelly

loam consists of very dark-brown friable gravelly loam. The next lower layer, which averages about 11 inches in thickness, is dark reddish-brown very sticky gravelly clay loam which rests directly on beds of stratified sand and gravel similar to those occurring beneath typical Fox gravelly loam. The content of gravel through the soil mass varies considerably.

This dark-colored soil is inextensive in Butler County. It occurs mainly in Miami Valley. Drainage conditions, surface features, general adaptation, and utilization are similar to those of the typical soil. During dry seasons, crop yields are a little higher than on typical Fox gravelly loam, owing to the greater moisture-holding capacity of this soil. The loose, well-drained, calcareous substratum renders the soil well suited to alfalfa.

FOX FINE SANDY LOAM

Normally developed Fox fine sandy loam, like other members of the Fox series, consists of four distinct layers. The surface layer, to a depth of 14 inches, is fine sandy loam. In forested areas 1 or 2 inches of very dark grayish-brown loamy fine sand is just beneath the forest débris. During cultivation this becomes mixed with the lighter-colored material below so that the cultivated soil is brown or grayish-brown fine sandy loam to a depth of 8 inches. The remainder of the surface layer is brown fine sandy loam with a faint reddish tint. It becomes heavier and stickier with increased depth. The second layer, extending to an average depth of 30 inches, is dark-brown sticky sandy clay tinged with red. This layer grades into reddish-brown or dark reddish-brown very sticky light sandy loam ranging from 4 to 8 inches in thickness. A rather sharp division occurs between this third layer and the stratified sand and gravel beneath it, which is composed chiefly of rounded pieces of limestone and dolomite. There is a wide range in the color of the individual sand grains and gravel fragments, but the gray and yellowish-gray colors predominate. Scattered pebbles of quartz, granite, chert, flint, and other hard rocks occur throughout the soil and on the surface. The second layer is slightly acid in most places, but the abundant lime in the gravelly substratum is within reach of many plant roots, particularly those of alfalfa and sweetclover.

Fox fine sandy loam occurs principally along the inner border of the second bottoms of Miami River. Rather large areas are south and southwest of Trenton and south and north of Middletown. Other tracts are along Talawanda Creek from Darrtown southeast to Miami Valley. Areas are nearly level, but small sandy knolls give a slight undulation in places. Drainage is very well established. As on other Fox soils there is very little surface run-off, the excess water passing downward to the gravelly substratum and then laterally to the streams.

More than 95 per cent of the soil is cleared and in a high state of cultivation. It is devoted chiefly to general farming. Crops grown and average yields are about the same as on Fox silt loam, except that during dry seasons the yields in the lighter areas of the fine sandy loam average a little less. A few small patches of cantaloupes and watermelons are grown as special crops.

FOX SANDY LOAM

Fox sandy loam has practically the same physical characteristics and succession of layers as Fox fine sandy loam, with the exception that the sand particles are coarser in the sandy loam soil. The land as a whole is exceptionally well drained, and some sandy knolls are excessively drained. As a rule, however, crops do not suffer from excessive drainage except during unusually dry seasons.

This soil is almost entirely devoted to the production of corn, wheat, clover, alfalfa, melons, and sweetpotatoes, named in the order of their importance. Crop yields compare very favorably with those obtained on the other Fox soils, though they are somewhat less than on the heavier members of the series.

Like Fox fine sandy loam, Fox sandy loam occurs on the inner borders of the second bottoms of Miami River and its larger tributaries on the northwest. The principal areas are near Venice, Woodsdale, and Amanda in Miami Valley. Others are 4 miles southeast of Darrtown in the valley of Talawanda Creek.

GENESEE SILT LOAM

Genesee silt loam, as it is typically developed on the broad, comparatively level first bottoms of the main streams, consists of yellowish-brown silt loam underlain at a depth of about 36 inches by cross-bedded and stratified sands and sandy gravel. Although the surface soil, to a depth ranging from 12 to 20 inches, is typically yellowish brown it ranges from light grayish brown to dark brown in places. The proportion of fine sand increases gradually as the sandy layer is approached, but the actual boundary between the two layers is sharply defined. The sandy substratum is decidedly calcareous, and the soil is not acid in any part of the profile. Fragments of shells are common over the surface and through the soil.

Considerable variation is found locally in this soil, as it is composed of materials gathered from widely separated sources, and most of it is still receiving fresh deposits during flood periods. In the valley of Mill Creek from Flockton southeast to the county line included areas have a 10 to 20 inch surface layer of brown silt loam underlain by dark brownish-gray plastic silty clay. Dark brownish-gray layers also occur locally in the deposits along Miami River. In places small areas of Genesee fine sandy loam, fine sand, and sand are included. This soil is closely associated with the Ross soils, and where it adjoins these soils the surface soil is darker than typical.

Genesee silt loam is mapped along the stream flood plains. The land surface is nearly level, except where old partly filled-in channels form depressions or where new channels are being cut.

Although this soil is subject to overflow during high water, most of it is cultivated each year. Dikes have been constructed in many places to check flood waters. The run-off is fairly rapid in most places, and flood waters recede in time to allow the planting of summer crops. However, tile drains are beneficial, especially in places where the substratum is heavy, as it is in parts of Mill Creek Valley.

Practically all this soil is under cultivation. Less than 10 per cent is utilized for pasture. The land is very fertile and produces excellent crops of corn and alfalfa. Yields of 115 bushels of corn to the acre are obtained, though the average is about 65 bushels.

Alfalfa yields 2 or 3 tons of hay to the acre during favorable seasons. Occasional floods cause much damage, but the hazard is becoming less as efforts are made to control flood waters in this region.

GENESEE FINE SANDY LOAM

To a depth ranging from 10 to 14 inches the surface soil of Genesee fine sandy loam consists of brown fine sandy loam. It is underlain by grayish-brown light fine sandy loam containing thin lenses of silty and clayey material. Below this layer the material grades downward to light grayish-brown loamy fine sand, and at an average depth of 30 inches gray fine sand and fine gravel are reached. As in other soils of the Genesee series, fragments of shells are scattered over the surface and through the soil, and lime is plentiful. Genesee fine sandy loam is mapped in the stream flood plains, immediately bordering the stream channels. The surface is nearly level or very gently undulating and in most places power machinery can be used.

The soil is subject to overflow during times of high water. The floods usually occur in early spring, but occasionally come later in the season after the crops are planted; the later floods cause considerable damage. Surface run-off and underdrainage are fair in most places. Very little of the land is artificially drained.

More than 75 per cent of the Genesee fine sandy loam is utilized for general farming and for special crops, the remainder, including areas which are comparatively low or are dissected by drainage channels, being used for pasture. The crops grown and yields obtained are similar to those on Genesee silt loam. Melons do especially well, and the acreage devoted to them is increasing. Sweet corn is also an important special crop to which the soil is well suited.

GENESEE SANDY LOAM

Genesee sandy loam has a grayish-brown sandy loam surface layer about 8 inches thick, underlain by yellowish-brown light-textured sandy loam continuing to a depth of about 24 inches, where it rests on gray loose and incoherent coarse sand and gravel. Lime is abundant throughout. Many small gravelly patches, indicated on the soil map by gravel symbols, occur, but this is not uniformly a gravelly soil.

One fair-sized area and several small areas of Genesee sandy loam are mapped along Miami River between Hamilton and the south county line. The relief and drainage of these areas are similar to those of Genesee fine sandy loam, though the more open structure of this soil makes it more subject to excessive drainage.

Less than 50 per cent of the land is cultivated at present; the remainder is lying idle, as old fields used for livestock runs or as a source of sand and gravel. Corn, wheat, melons, and some alfalfa are grown, but the yields are generally low. Wild hay is harvested from a few of the old fields. Practically all this soil has been cleared of its original growth of sycamore, elm, cottonwood, locust, white oak, and silver maple.

GENESEE FINE SAND

The 12 or 14 inch surface layer of Genesee fine sand is grayish-brown rather loose fine sand which is slightly coherent when wet.

This grades downward into loose and incoherent yellowish-gray fine sand of varying thickness, depending on the thickness of the original deposit. Coarse sand and gravel are present in the substratum in many places.

This soil is of very small extent and occurs only in Miami Valley. It occupies low-lying natural levees along the streams and old abandoned channels. The relief is undulating. Small areas of a coarser-textured phase containing much medium sand occur on the inner sides of bends along Miami River, one 3 miles northeast of Hamilton, others west of Amanda, and one northeast of Middletown near the county line.

Most of this soil is covered at times by flood waters. However, the ground water level is 5 or more feet below the surface for the greater part of the year and this, together with the sandy texture of the soil, allows thorough drainage. Most of the land is cultivated with the adjoining bottom soils. Yields average less than on the heavier soils of the Genesee series. Corn and alfalfa are the principal crops, and melons, cucumbers, and wheat are grown to less extent.

BROOKSTON SILT LOAM

Brookston silt loam includes most of the dark-colored soils in the smoother upland regions. The surface soil, to a depth of 6 or 8 inches, is very dark grayish-brown silt loam which is almost black and moderately sticky and plastic when wet. Below this and continuing to a depth ranging from 10 to 20 inches, is a very dark grayish-brown or bluish-gray moderately plastic and gummy silty clay loam. Faint yellow and brown stains appear in the lower part of the surface soil, becoming more pronounced with depth. The next lower layer, which averages about 16 inches in thickness, is yellow moderately plastic silty clay loam mottled with gray and specked with dark-brown iron stains. It grades into bright-yellow floury, sticky, plastic silt loam which rests on calcareous gravelly loam at a depth ranging from 46 to 72 inches. The materials are neutral or slightly alkaline in reaction throughout the entire soil.

Considerable variation occurs in the thickness and texture of the dark surface layer. The thickness ranges from 6 to 30 inches and the texture from silt loam to silty clay loam, the heavier texture occurring in the more poorly drained situations where this soil grades into Clyde silty clay loam. Where the soil grades into the better-drained upland soils the brown and yellow colors are as a rule more pronounced.

Brookston silt loam occurs in rather small irregular-shaped patches in the upland region of the county. The land surface is level or very gently sloping to the centers of the shallow depressions in which the soil has developed. Some of the largest areas, in parts of which the texture is heavier than typical, are in Mill Creek Valley between Flockton and the south county line. The soil occurs in numerous small depressions in the extreme northwest corner of the county and also on the smooth uplands in the vicinity of Jacksonburg and Monroe.

Neither surface nor internal drainage is adequate, and most of the soil has been artificially drained either by open ditches or tile drains.

The soil is very retentive of moisture, holding an adequate supply at all times.

Seventy-five per cent or more of the Brookston silt loam is cleared and cultivated at the present time. The remainder is in forest and grass. The tree growth consists principally of elm, ash, beech, bur oak, silver maple, and hickory, with some sugar maple, walnut, and white oak.

This is one of the most fertile soils in the county. It is especially suited to the production of corn, and yields of 75 or more bushels to the acre are common. Wheat, clover, and oats are also grown extensively in rotation with corn. Wheat and oats commonly produce a heavy straw growth and sometimes lodge before the crop is mature. The surface soil is mellow and easily tilled, and the tilth is easily maintained if the land is not handled when too wet.

Brookston silt loam ordinarily receives the same fertilizer treatment as the Fincastle and Russell soils, with which it is associated. In applying barnyard manure this dark soil is sometimes purposely avoided and the manure is scattered on the thinner lighter-colored soils which are low in organic material.

MONTGOMERY SILTY CLAY LOAM

Montgomery silty clay loam resembles Brookston silt loam in color, thickness, and arrangement of the upper horizons, but differs in having a calcareous, smooth, heavy clay substratum instead of a gravelly, gritty loam substratum. The typical surface soil consists of very dark brownish-gray silty clay loam which appears almost black when wet. Below an average depth of 5 inches this material gives place to very dark brownish-gray heavy plastic waxy silty clay specked with brown and dark-brown iron stains. The iron stains become more numerous with depth, and at a depth of about 24 inches yellow streaks and mottles appear. This material grades into a layer of sticky plastic clay, predominantly yellow, but intricately mottled with dark gray and yellowish brown and specked with dark-brown iron stains. A heavy clay substratum, predominantly brown, with light-gray and bluish-gray material occurring in thin intersecting streaks and seams, lies at a depth of about 56 inches. A fine lamination of the clay particles is noticeable in places, indicating deposition in quiet water. The entire soil is alkaline, and the heavy clay substratum effervesces very freely in cold dilute hydrochloric acid.

Minor variations occur in this soil as mapped. The thickness of the surface layer ranges from 8 to 36 inches and the color from dark gray to black. In the wettest situations the gray and bluish-gray colors predominate. In a number of places, such as 1 mile west of Blueball, sandy clay, sandy gravel, or gravel layers occur just above the heavy clay substratum.

Montgomery silty clay loam occurs principally southeast of Middletown in the broad, nearly level valley occupied by Dicks Creek. A few scattered areas are southeast of Shandon in the rather broad valley occupied by Paddys Run and in the abandoned valley 3 miles southeast of Hamilton. The land is nearly level.

Artificial drainage is needed for the best utilization of this soil, most of which has been tile drained. The water table lies from 60

to 100 inches below the surface. Like Brookston silt loam this soil is very retentive of moisture.

General farming, with a corn, wheat, and clover rotation, is the principal utilization of the land. Alfalfa is grown to a small extent. This is an excellent trucking soil, especially well suited to cabbage, beets, lettuce, tomatoes, sweet corn, and potatoes. Beans, peas, pumpkins, and squash do well.

Montgomery silty clay loam ranks with the Brookston and Genesee soils as one of the most fertile in the county. Very little commercial fertilizer is used, except for wheat. The fertility is maintained by following a rotation including legumes and by applying manure.

McGARY SILT LOAM

McGary silt loam is a light-colored soil associated with the dark-colored Montgomery silty clay loam. The substratum of both is heavy, calcareous, slack-water clay. The surface 2 inches of McGary silt loam in forested areas contains sufficient organic matter to darken the material to very dark grayish brown, but the dry plowed surface soil is light gray. The smooth silt loam texture continues downward to a depth of 10 or 12 inches, to which depth the color is gray but is marked by fine spots and streaks of yellow and brown. The particles in this layer are in many places arranged in poorly defined thin horizontal lenses less than 1 inch long. Below this layer is a layer of dark-brown heavy silty clay, rather plastic and sticky when moist and averaging about 8 inches thick, in which the cleavage or breakage planes are coated with a film of gray material. The material beneath the second layer is clay in texture and is dark brown with gray and drab coatings along root channels and cleavage crevices. When moist it is very sticky and plastic. At an average depth of 35 inches the calcareous heavy brown clay substratum with a network of thin intersecting bluish-gray seams is reached. This material is commonly massive in appearance, with a fine lamination noticeable in places. Light-gray nodular lime concretions are common throughout the substratum. The rather thin heavy silty clay layer which occurs 10 or 12 inches below the surface is acid in reaction, but the remainder of the soil is neutral or alkaline, and the substratum has a comparatively high lime content.

This soil is rather uniform in its development, though areas of the gravelly substratum phase and of a loam soil are included because of their small extent and intimate association. The depth to the unweathered slack-water clay substratum is variable, ranging from 2 to a maximum of 5 feet.

McGary silt loam occurs southeast of Middletown along Dicks Creek and south of Shandon along Paddys Run. The surface configuration is very gently undulating. Drainage is not well established, being only moderate on the surface and comparatively slow through the heavy subsoil and substratum. Open ditches and tile drains improve drainage conditions, and the soil is so situated that drainage outlets are readily obtained.

A few small wood lots remain as remnants of the original forest of ash, elm, beech, silver maple, hickory, and red oak. Approximately 95 per cent of the land is cleared and under cultivation, chiefly to

corn, wheat, and clover. The soil is very well suited to the production of wheat and clover, and corn also does well though the yields are less than those obtained on the Montgomery and Brookston soils. Wheat is ordinarily fertilized, and clover commonly receives a top-dressing of manure. Small patches are used for garden products, sweet corn, and small fruits. Alfalfa and sweetclover are grown to a small extent. Sweetclover is especially helpful in loosening the heavy subsoil characteristic of this soil.

McGary silt loam, gravelly substratum phase.—The gravelly substratum phase of McGary silt loam is practically identical with typical McGary silt loam to an average depth of 36 inches. Below this depth the phase is much lighter in texture, consisting of mottled gray, yellowish-gray, and yellowish-brown silt loam, 12 or 14 inches thick, underlain by brown, yellowish-brown, and dark-brown gravelly sand 8 or 10 inches thick. The gravelly layer rests directly on the calcareous slack-water clay which is identical in all respects to the corresponding clays beneath typical McGary silt loam and Montgomery silty clay loam.

Only a few small areas of this soil between Amanda and the east county line are mapped. The land is very gently undulating, and surface drainage is not well established. The gravelly substratum improves internal drainage considerably, but some tile drainage is generally considered beneficial.

All this soil is farmed, chiefly to corn, wheat, and clover. Crop yields and requirements are practically the same as on the typical soil.

ROSS SILT LOAM

To a depth of 20 or 30 inches Ross silt loam consists of very dark grayish-brown silt loam, which is very slightly plastic and sticky when moist but does not clod badly and is easily maintained in good tilth. The brown color becomes more pronounced and the content of fine sand increases gradually downward through the surface layer which is underlain by a comparatively thin layer of compact fine loam grading rather abruptly into a layer of loose incoherent gravelly sand at an average depth of 43 inches. Gray and yellowish-gray colors predominate in the sandy substratum, though the individual grains of sand have a wide color range. Fragments of shells are found through the soil and on the surface. The soil is alkaline in reaction throughout.

The texture, color, and thickness of the surface layer differ from place to place, and as a rule a very gradual change takes place between this soil and the bottom soils adjoining it. In places the dark silt loam layer rests directly, at a depth of 20 or 30 inches, on beds of stratified sand and gravel, and in other places the dark color extends to a depth of 4 or more feet with little variation. Lighter-textured variations, which include some areas with fine sandy loam and loam surface soils, occur on higher first bottoms of Miami River, Talawanda Creek, and Indian Creek.

Ross silt loam is one of the less extensive soils in Butler County. It occurs in comparatively small, irregular-shaped areas along the first bottoms of some of the main streams, occupying, in most places, nearly level situations farther removed from the stream channel than areas of the associated Genesee soils. The land is subject to overflow

during times of extremely high water, but, as in the Genesee soils, surface and internal drainage are sufficiently rapid to remove standing water, so that most of the soil is cultivated regularly.

More than 95 per cent of the Ross silt loam is cultivated at present. Corn and alfalfa are the principal crops, and some wheat is grown. The soil is very fertile, often producing 75 or more bushels of corn to the acre. Wheat yields range from 20 to 30 bushels to the acre, and alfalfa produces from 1 to 2½ tons during favorable seasons. Wheat is practically the only crop fertilized on this soil.

EEL SILTY CLAY LOAM

To a depth of 8 or 10 inches Eel silty clay loam consists of very dark-brown silty clay loam which is moderately plastic and sticky when moist. When dry it is a shade lighter in color, the clods become very hard and difficult to crush, and the immediate surface soil has a tendency to crack. Below the surface layer is dark-brown heavy silty clay loam, the particles of which are coated with dark grayish brown, giving an intricate association of the two colors. The soil material of this layer, which averages about 18 inches in thickness, is very sticky and plastic when wet. The next lower layer, continuing to a depth of 50 or 60 inches, consists of very dark grayish-brown or bluish-gray clay or clay loam containing many small yellow and brown iron specks and stains. It is underlain by a massive brownish-yellow, yellowish-gray, and dark-gray heavy silty clay loam layer, only slightly sticky and plastic and easily crushed when air-dry. Pieces of shells and angular rock fragments, ranging in size from fine sand to coarse gravel, are present in small numbers throughout the entire soil. The soil is not acid.

The color of the surface layer ranges from brown to very dark gray, but the dark tints are most common. In the most poorly drained situations, where the soil is saturated for considerable periods, the entire upper part of the soil is gray or bluish gray.

Eel silty clay loam occupies nearly level or slightly depressed areas and in some places occurs in old channels. The principal development is southeast of Hamilton in Mill Creek Valley, where the soil occupies the most poorly drained situations in the broad valley. Two small patches occur in Miami Valley, one 1 mile north of Hamilton and the other 1 mile south of Fairplay near the south county line. Both surface and internal drainage are inadequate, and as a rule artificial drainage is resorted to before the soil is farmed. Large open ditches have been dug for the main drainage arteries, and tile drains have been extended into the fields.

Practically all the land has been cleared. Approximately 85 per cent is cultivated at the present time, and the remainder is utilized for pasture. Corn, clover, and alfalfa are the chief crops. The better-drained areas produce yields comparing very favorably with those obtained on other fertile bottom soils. However, corn is subject to occasional injury from early frost and to damage from standing water in the lower situations during wet seasons. Fertilizers are not generally used. Alfalfa and other legumes adapted to the region grow fairly well if the weeds are kept down until the crop has become well established.

WARSAW LOAM

Warsaw loam is characterized by a very dark-brown slightly sticky loamy surface soil extending to an average depth of 20 inches, where it grades into dark reddish-brown loam or sandy clay loam, which is very sticky when wet. At a depth of approximately 36 inches this layer rests on beds of loose gray calcareous stratified gravel. The two layers above the gravel are slightly acid or neutral in reaction.

In included areas the texture of the second layer ranges from sandy loam to silty clay loam. The areas lying 4 miles northwest of Jacksonburg near the county line, a part of the one 3 miles east of Coke Otto, and another just east of Sevenmile have comparatively heavy surface soils and upper subsoils of sandy clay loam. Other small patches of the soil are mapped 1½ miles southeast of Trenton and about 1 mile northwest of Shandon. The total area of this soil is very inextensive.

Surface drainage is fairly well established, and the gravelly substratum allows good internal drainage. In agricultural value and utilization, this soil is practically the same as Fox silt loam.

WARSAW SILT LOAM, DEEP PHASE

The surface soil of the deep phase of Warsaw silt loam is moderately plastic dark grayish-brown silt loam to a depth of 6 inches and very dark grayish-brown silty clay loam below this to a depth of about 18 inches. Between depths of 18 and 39 inches the material is yellowish-brown and brown plastic silty clay loam into which dark-colored material from above has penetrated. This layer is underlain by a 10-inch layer of very sticky brown gravelly clay loam tinged with red and yellow, in which the fine material is rather plastic. At a depth of approximately 48 inches there is a layer of calcareous clayey gravel which within a few feet grades into clear, washed gravel.

In included variations the dark-colored surface layer ranges from 12 to 40 inches in thickness and from almost black to dark grayish brown in color, and the gravelly substratum lies at a depth ranging from 40 to 72 or more inches.

Only a few small areas of this soil are mapped, chiefly on the west side of Miami Valley between Trenton and Sevenmile. One area having a thick dark-colored surface layer and a deep gravelly substratum is three-fourths mile south of Millville on the west side of Indian Creek. This soil occupies shallow irregular-shaped depressions on the broad outwash plains, and natural drainage is imperfect. Practically all the soil is cultivated and produces excellent yields of corn, wheat, clover, alfalfa, and other crops which are commonly grown on the adjoining Fox soils.

CLYDE SILTY CLAY LOAM

Virgin Clyde silty clay loam has a 3 or 4 inch surface layer of very dark brownish-gray silty clay loam which is very high in organic matter. Plowing mixes this layer with the iron-stained black silty clay layer beneath it, so that cultivated land is nearly black. The surface material is sticky and plastic when wet and if worked in this condition is apt to dry into very hard clods. The surface soil

cracks during dry weather. Beneath the surface layer is tough, sticky, plastic silty clay extending to an average depth of 50 or more inches. The upper 12 or 14 inches of the subsoil layer is dark bluish gray, with numerous brown and dark-brown iron stains and specks. In the lower part yellow and brown colors become more pronounced and give the bluish-gray material a much yellower color than the material above. Gray, yellow, and brown calcareous gravelly clay loam or clay loam glacial till or bowlder clay lies at a depth ranging from 50 to 80 inches. This material is plastic and sticky when wet but dries into a very hard mass which is not easily crushed.

Clyde silty clay loam occurs in small, scattered, basinlike areas in the uplands from Jacksonburg west to the county line. Areas are level or gently sloping toward the centers of the shallow depressions. Surface draniage and underdrainage are naturally very poor, and many areas remain wet most of the year. The soil is not acid in reaction.

Plant-food elements are plentiful, and areas that are adequately drained and properly handled produce well. Corn, wheat, clover, and oats are the principal crops.

BELLEFONTAINE SILT LOAM

Bellefontaine silt loam has a smooth silt loam surface soil 12 inches thick. In virgin areas the 1 or 2 inch surface layer is dark brown because of its high organic-matter content. The plowed surface has a reddish cast, which is especially pronounced when the soil is wet. In the lower part the surface soil changes, through a 2 or 3 inch gradational layer, into reddish-brown sticky plastic silty clay loam. Below a depth of 19 inches considerable gritty material is present. At an average depth of 30 inches dark reddish-brown sticky gravelly silty clay loam occurs as a thin wavy layer resting directly on calcareous stony gravel. The substratum material ranges from fine sand to large limestone slabs and hard rock bowlders from 1 to 2 feet in diameter. The surface layer is only slightly acid or neutral, but the heavy layer is acid in reaction to within a few inches of the gravel bed.

Considerable variation in the thickness of the silt loam surface layer occurs. In the smoother areas it reaches a total of 14 or 16 inches, but where erosion has been more active it is only 8 inches or less in thickness, and the gravelly substratum is correspondingly nearer the surface.

The largest areas of Bellefontaine silt loam have developed on the rolling lands and slopes bordering Mill Creek Valley on the east, near the village of Westchester, and south to the county line. Smaller areas occur along the valleys of Elk and Sevenmile Creeks. Drainage is excellent. The soil is acid in only a few places.

At least 75 per cent of the land is utilized for general farming, with corn, wheat, clover, and alfalfa as the chief crops. The soil is also well suited to tobacco, hay crops, and orchard fruits. Crop yields, fertilizer requirements, and general farm practices on the smoother areas are practically the same as on the closely associated Russell silt loam. The native forest consists of sugar maple, walnut, and red oak, with some beech, elm, white oak, and poplar. Bluegrass grows well and affords excellent pasturage on the more rolling areas.

BELLEFONTAINE FINE SANDY LOAM

Bellefontaine fine sandy loam has a brown or dark-brown rather loose fine sandy loam surface soil about 12 inches thick. In the lower part the material has a red cast and grades into reddish-brown slightly sticky light sandy clay from 18 to 22 inches in thickness. This material gradually becomes sandier with depth and grades at about 32 inches into light reddish-brown loamy fine sand or fine sandy loam. Loose stratified fine sand and sandy gravel, containing a high proportion of lime, lie between depths of 40 inches and several feet. The sandy clay layer is in most places moderately acid, but the remainder of the soil is neutral or alkaline.

Drainage is well established, and in places where the loose sand and gravel substratum occurs near the surface it becomes excessive at times and crops are subject to injury from droughts.

This soil is very inextensive. The smoother areas are used for corn, wheat, clover, alfalfa, and truck crops, and the rougher ones are forested or are in grass. The substratum material of both the silt loam and the fine sandy loam members of the Bellefontaine series are utilized as a source of gravel and sand.

Areas of Bellefontaine fine sandy loam occur near Fairsmith, southeast of Hamilton, 2 miles east of Amanda, on a number of long narrow ridges rising from 10 to 15 feet above the surrounding plain, and, in one small isolated patch, 2½ miles northwest of Jacksonburg bordering the north county line.

MIAMI SILT LOAM

Miami silt loam is yellowish-brown smooth silt loam to a depth of about 10 inches. In the lower part of the layer the material changes, through a 2 or 3 inch gradational layer, into moderately plastic brown silty clay loam, continuing to an average depth of about 27 inches. The lower part of this second layer becomes heavier and contains scattered angular pebbles and fine grit. It is moderately friable, but when moist is sticky. A dark-brown and gray coating occurs on exteriors of natural broken faces. The next lower layer is the friable calcareous clay loam parent material. Forested areas contain enough organic matter in the topmost 2 inches to impart a dark grayish-brown color to the soil. This surface humous soil is neutral in reaction, but beneath it the soil material is acid to within a few inches of the calcareous parent material. As a rule, there is a little gradation through a layer which is neutral or nearly neutral in reaction, but this zone is not so prominent in this soil as in the corresponding layer of Russell silt loam.

Miami silt loam is of minor importance in Butler County, but is extensive in counties to the north. It occurs on well-drained interstream areas north of Astoria in Madison Township. The land surface is undulating or gently rolling, and drainage is fairly well established, though tile drainage is considered beneficial for the smoother areas.

The type of agriculture, crops grown, fertilizer requirements, and yields are very similar to those on Russell silt loam, which this soil closely resembles. Approximately 75 per cent of the land is cultivated, and the remainder is in forest and grass land. The virgin forest, of which only scattered patches remain as farm wood lots,

consisted chiefly of sugar maple, red oak, and walnut, with some beech, elm, hickory, wild cherry, and tuliptree. Most of this soil is slightly acid in reaction.

CINCINNATI SILT LOAM

Cincinnati silt loam in forested areas has a silt loam surface layer from 12 to 16 inches in thickness, which is very dark grayish brown to a depth of 2 inches and yellowish brown beneath. The plowed soil is brown. Below the surface soil is a layer of brown plastic silty clay loam, from 18 to 22 inches in thickness, which has a reddish cast and coatings of gray along the natural cleavage lines. The silty clay loam texture continues downward to a depth of about 50 inches, but the material gradually becomes brownish gray and brown and is sandier. Many small intersecting holes are noticeable in this layer, and iron specks and dark-brown concretionary pebbles are present. Below a depth of 50 inches the material is brown and yellowish-brown plastic silty clay marked by gray seams, dark-brown iron stains, and scattered iron concretions. Bluish-gray and brownish-yellow gritty clay loam containing considerable lime occurs at depths ranging from 60 to 120 inches. In most places the soil is acid to a depth ranging from 3 to 4 feet and grades downward through a very slightly acid or neutral layer into the limy parent material.

Cincinnati silt loam varies considerably in depth to the calcareous layer. Where bedrock lies 5 or more feet below the surface a calcareous layer occurs in most places, but where the rock is nearer the surface the readily soluble lime is leached out down to the bedrock. The amount of gray coloring increases as the smoother areas are approached and the soil grades into Rossmoyne silt loam.

This soil occurs in the extreme southeast corner of the county and along and near the county line south and southwest of Hamilton. It occupies rolling uplands and narrow rounded ridge tops, where drainage is well established.

More than 50 per cent of the land is used for pasture and forest land. Red oak, hickory, sugar maple, walnut, and locust, with some beech, poplar, ash, and elm, constitute the tree growth. The principal crops are corn, wheat, oats, and timothy. Some red and alsike clover are grown, though liming is required for a good crop. Corn yields about 30 bushels to the acre, wheat 14 bushels, oats about 30 bushels, and timothy about 1 ton of hay. The surface features and character of this soil make it desirable for peaches, apples, and other orchard fruits, and it produces fruit of good quality.

ROSSMOYNE SILT LOAM

Rossmoyne silt loam occupies an intermediate position between the well-drained Cincinnati soils and the poorly drained Clermont soils of the upland flats. The surface layer is grayish-brown floury silt loam about 15 inches thick. It is underlain by intricately mottled light-gray, gray, grayish-brown, yellow, and brown silty clay loam extending to a depth of about 60 inches. The next lower layer is plastic silty clay, predominantly gray, which continues to the bluish-gray and brown calcareous silt loam or clay loam parent material. The striking feature of this soil is the fact that lime and the

other readily soluble constituents have largely been leached from the soil to a depth of 10 or 12 feet, and the soil material is acid to a depth of 4 or 5 feet, below which a neutral zone forms the gradational layer overlying the calcareous parent material. Dark-brown and yellow iron stains and specks are present through the entire soil, except the parent material, and scattered iron concretionary pebbles are common.

Only three small areas of this soil, in the extreme southeast corner of the county, are mapped. The land has a gently undulating relief and has fair surface drainage but very poor underdrainage.

The principal crops, yields, and fertilizer requirements on this soil are similar to those on Cincinnati silt loam.

CLERMONT SILT LOAM

Clermont silt loam is distinguished by its flat surface, light-gray surface layers, deeply leached soil material, and poorly drained condition. To a depth of 8 or 10 inches the material is floury silt loam, underlain by mottled light-gray and yellowish-brown silt loam with many rust-brown iron specks. This becomes heavier at a depth of about 16 inches and at an average depth of 22 inches grades into mottled yellowish-brown and gray plastic silty clay with rust-brown stains and specks. At 36 inches predominantly dark-gray clay, tough and plastic and containing dark-brown concretionary pebbles, occurs. The thickness of this layer averages about 46 inches. Below this layer and continuing to an average depth of 120 inches is plastic clay mottled yellow, gray, and bluish gray, which merges into friable yellow, gray, and brown clay loam containing sufficient lime to effervesce freely in dilute acid. Small sharp rock fragments of a maximum of one-half inch in diameter are scattered through the soil. These fragments are chiefly limestone below a depth of 120 inches, but above this depth they consist chiefly of very hard rock, such as granite, chert, flint, quartzite, and diorite.

Clermont silt loam is very inextensive. It occupies a nearly level area in the extreme southeast corner of the county and extends for three-fourths mile along the east county line. It is naturally very poorly drained and is extremely deficient in lime and other necessary plant-food elements.

FAIRMOUNT SILT LOAM

The surface 3 to 6 inch layer of Fairmount silt loam consists of very dark-brown slightly plastic silt loam. This material grades downward into reddish-brown heavy silty clay loam which is plastic and sticky when moist but firm and moderately friable when dry. Greenish-yellow or olive-gray highly calcareous clay occurs at an average depth of 20 inches and extends to the bedrock of interbedded limestone and shale. Loose slabs of limestone are common on the surface and through the soil, being very numerous in the clay layer just above the bedrock. Commonly the soil is neutral or alkaline in reaction throughout.

Much of this soil has only a thin veneer of silt loam on the surface, owing to the washing away of exposed surface material. Small areas of Fairmount silty clay loam were included in mapping.

Fairmount silt loam has developed principally on the slopes of the short V-shaped valleys which extend back from the major streams.

The main development is southwest of Hamilton on the breaks along Miami River and in the rolling section from Middletown west to Collinsville. Small areas occur in all parts of the county, with the exception of the extreme northwest part. The heavy and stony subsoil and substratum prevent rapid gullying, but the soil is subject to surface wash, and under continued cultivation erosion becomes a serious problem.

A considerable proportion of this land has been cleared and placed under cultivation at different times, but after a year or two of cropping it is commonly seeded to Kentucky bluegrass, sweetclover, or alfalfa, which is allowed to remain for a few years. Kentucky bluegrass grows very rank, and sweetclover and alfalfa do very well when once established. Good yields of corn are obtained in the more favorable situations, and the soil is well suited to the production of Burley tobacco. Most of the uncultivated areas are open wood lots utilized for pasture land. Sugar maple, walnut, poplar, ash, elm, white oak, and red oak are the common trees.

FAIRMOUNT SILTY CLAY LOAM

Fairmount silty clay loam in the virgin condition has a 2 or 3 inch surface layer of very dark grayish-brown silty clay loam which is moderately plastic when moist. The cultivated surface soil is light grayish brown when dry. The next layer, ranging in thickness from 6 to 10 inches, is dark grayish-brown and yellowish-brown plastic heavy silty clay loam in which the colors are intricately associated. This grades, through a 1 or 2 inch transitional layer, into yellowish-gray and olive-gray silty clay which is very plastic and sticky when moist. At a depth of about 18 inches the color becomes pronounced olive yellow and olive gray and the texture moderately plastic clay. Limestone slabs occur on the surface and through the soil, and the bedrock occurs in most places within a depth of 30 inches. The soil material is alkaline from the surface down to bedrock, and the olive-tinted clay effervesces with acid.

This soil occupies situations on the steeper slopes of the main valleys, and scattered outcrops of bedrock occur in it. The largest areas are south of Hamilton on the west valley slopes of Miami River and west of Middletown on the steep slopes along Elk Creek Valley. The surface run-off is rapid, but internal drainage is slow through the heavy clay subsoil. Springs of clear water are common along the slopes on which this soil and Fairmount silt loam occur.

Less than 5 per cent of the soil is cultivated at present. Cultivated areas are in apple and pear orchards and small scattered patches of corn and tobacco. These crops do very well. As a rule the intertilled crops are not grown more than two years in succession, and they are followed by bluegrass, sweetclover, or alfalfa as cover crops to check erosion. The native trees are chiefly elm, ash, hickory, and walnut, with which are intermixed red cedar, poplar, and wild cherry. Much of the soil is naturally well suited to forestry.

SHANDON FINE SANDY LOAM

Shandon fine sandy loam has a surface layer of dark-brown fine sandy loam about 12 inches thick. The topmost surface soil in forested areas is very dark brown, and the plowed surface soil is brown

or grayish brown. A thin gradational layer intervenes between this layer and the reddish-brown fine sandy clay loam layer which continues to an average depth of 25 inches. The sandy clay loam texture continues to a depth of about 45 inches but the color changes to brown and many dark-brown iron specks and stains are present, distinguishing this layer from the one above. In the lower part it becomes slightly heavier and is rather sticky. It is underlain by brown and bluish-gray calcareous, plastic, slack-water clay which corresponds to the calcareous clay formation beneath the McGary and Montgomery soils. Scattered through the soil and on the surface are a few angular fragments of chert, quartzite, and granitic rocks. To a depth of 12 inches the soil material is neutral or alkaline in reaction, below that depth it grades into a decidedly acid layer, and with increasing depth the acidity decreases to the calcareous clay substratum.

In places sandy material from 6 to 10 feet in thickness overlies the slack-water clay deposit. In such places the upper part of the soil is similar to the typical soil, but directly beneath the shady clay loam layer a layer of loose incoherent fine sand reaching a maximum thickness of 10 feet, rests rather abruptly on the slack-water clay. The lower part of the fine sand layer is in most places decidedly calcareous.

Shandon fine sandy loam is very inextensive. The largest areas occur east and southeast of Amanda, where the soil occupies small, low-lying, smooth-topped knolls and ridges which stand out in rather sharp relief on the surrounding plain. Drainage is well established and is excessive in places where the loose sands extend to considerable depth.

Practically all the land is cleared and cultivated in association with the adjoining Montgomery and McGary soils. Owing to its small extent, it is not an important agricultural soil in this county, though fair yields of corn, wheat, clover, and alfalfa are obtained.

WESTLAND LOAM

Westland loam has a dark brownish-gray loam surface layer from 5 to 9 inches in thickness. The air-dry color is light brownish gray. This layer is underlain by slightly sticky clay loam grading from gray, yellow, and yellowish brown in the upper part to dark grayish brown, brownish yellow, and brown below. At an average depth of 24 inches the material merges into yellow, brown, and gray sticky gravelly fine sandy clay, which at a depth of about 36 inches gives way to grayish calcareous sandy gravel. The materials of this layer are not well assorted, ranging in size from fine clay to coarse gravel; the thickness ranges from 3 to more than 6 feet. In a few places the depth to the gravelly substratum reaches a maximum of 6 feet. Scattered subangular fragments of the more resistant rocks are on the surface and through the soil mass. The surface soil is slightly acid in most areas, but the rest of the soil is alkaline in reaction.

A few areas of Westland silt loam and Westland fine sandy loam are included in mapping, owing to their small extent. Westland loam occurs in the vicinity of Shandon, southeast of Hamilton, southeast of Sevenmile, and northwest of Jacksonburg. The areas are

nearly level. Surface drainage is only moderately good, and internal drainage is inadequate, therefore artificial drainage is considered beneficial.

More than 95 per cent of this land has been cleared and is cultivated at the present time. Corn, wheat, clover, and oats are the chief crops, and where drainage deficiencies have been corrected fair yields are obtained. Only a few small patches of forest remain. The common trees are beech, elm, ash, white oak, and soft maple, with which are intermixed some sugar maple and walnut.

RIVER WASH

River wash consists of such materials as sand, gravel, bowlders, and driftwood which have accumulated along the channels of the main streams. With each freshet, new material is added or parts of the old carried away or reworked. Areas of river wash are rough, owing to the presence of shallow pits and channels.

River wash is mapped principally along Miami River. The areas are not cultivated but afford some pasture. Sycamore, willow, elm, and some ash comprise the tree growth.

SOILS

The soils of Butler County have developed under the influence of a humid-temperate climate in a region forested with hardwood trees.

The topography of the county is a complex combination of the constructional and destructional types. The original dissected plain after being partly leveled by glacial action was subsequently invaded by the headward advance of numerous streams along this part of the Ohio Valley. This resulted in the present rather highly dissected region in which only very small remnants of level interstream areas remain. Over most of the county drainage is well established, and leaching of the surface layers is active during the greater part of the year. Oxidation has been active in these well-drained soils, resulting in a predominance of brown and yellow colors.

Conditions have not been favorable for the accumulation of organic matter except locally where poor drainage, recently deposited material, or the mineral composition (such as an abundance of lime) favors its retention. For this reason the predominant soils of the county are light colored. The light-colored soils are represented principally by members of the Russell and Fincastle series, though small areas of Miami and Cincinnati soils also occur. The Bellefontaine, Fox, and Shandon soils are also developing characteristics similar to those common to the region.

In a few places conditions have favored the development of dark-colored soils. The Brookston, Clyde, and Montgomery soils are dark-colored soils which developed in poorly drained situations where organic material has accumulated. The Ross soils are dark-colored alluvial material which apparently was dark when deposited.

The Fairmount soils are comparatively dark in their natural state, apparently because an abundance of lime has favored the accumulation and retention of organic material. The Fairmount soils have developed on the steeper slopes from the limestone and shale rocks which underlie them at a slight depth. The dark-colored surface layer is rapidly removed by erosion in cultivated areas.

The regional profile, as represented by Russell silt loam, is podsolic in its characteristics. This soil, as it has developed in undisturbed forested areas, has a thin accumulation of forest litter on the surface, and only a suggestion of leaf mold appears at the surface of the mineral soil. The A horizon is silt loam, normally about 12 inches thick. To a depth of 2 inches organic material has imparted a dark grayish-brown color. The materials hold together in irregular-shaped clods as the layer is broken, but the clods are easily crushed in the hand to a friable floury mass. Cylindrical worm casts, about one-sixteenth inch in diameter and from one-half to 1 inch in length and darker than the surrounding material, are most common in the upper part of the A horizon, though they occur to a depth of 12 or more inches. The dark color gradually fades and between depths of 2 and 12 inches the color is brown when the soil is moist, but light grayish brown when air-dry. Thin, short horizontal lenses commonly occur in the upper part of this layer, and, when the mass is broken, fragments of these lenses cling to plant rootlets. In place they cause the layer to have a fine laminated appearance. The top of the lens is sprinkled with gray and the lower part is, as a rule, brownish gray. The air-dry fragments are readily broken by a shearing force with the fingers, but it requires firm pressure to crush them by direct force.

The B horizon is silty clay loam averaging about 28 inches thick. Only a slight gradation of texture through from 1 to 3 inches of material occurs between the A and B horizons. Between average depths of 12 and 24 inches the normal color is dark brown with a faint reddish hue. The mass breaks apart into angular fragments ranging from one-fourth to one-half inch in diameter. A sprinkling of grayish-brown material is noticeable on some of the cleavage faces, and a shiny dark-brown film appears on others. The interiors of the fragments as a rule are more yellowish and less reddish than the exteriors. Fine dark-brown specks or iron stains are noticeable on a cut surface. In an air-dry condition the angular fragments are very hard, requiring a shearing force to break them by hand, but when wet the materials are moderately plastic and sticky. Between average depths of 24 and 40 inches the color is grayish yellow and reddish brown, the reddish material appearing along cleavage and seepage lines as an intrusion from above. The lower part of the B horizon contains an appreciable quantity of gritty and gravelly material and breaks naturally into irregular-shaped lumps which may be angular or curving on the broken face. When moist the material is stickier and more plastic than that of the layer above, even though it contains more sandy and gravelly material. The colloid content is high. These fragments dry to a hard mass which is difficult to crush but breaks readily under a shearing force in the hand.

Throughout the A and B horizons are many very fine pores, which are most numerous in the lower part of the A and the upper two-thirds of the B horizon and are noticeable when the soil is either wet or dry. Root hairs pass through some of these pores, the inside of some of which is coated with a thin grayish film and of others with dark brown. Roots penetrate to all layers but are most numerous in the A and the upper part of the B horizons. Fine roots follow along

the cleavage planes and also pierce the soil aggregates. The color of the walls surrounding the roots ranges from dark brown to gray. The main root systems of trees and shrubs spread horizontally through the A and upper B horizons, but the taproots and other larger roots reach to greater depths.

The C horizon consists of grayish-yellow and gray gravelly calcareous glacial till. Approximately 85 per cent of the rock fragments are limestone or dolomite and the remainder consist of a variety of exotic rocks such as granite, quartzite, diorite, chert, and other resistant rock. It is these more resistant rock fragments which occur scattered through the upper part of the soil and on the surface.

The reaction of the upper part of the A horizon ranges from slightly alkaline or neutral to very slightly acid, and the acidity increases with depth through the A and upper B horizons, but below an average depth of 24 inches the material gradually becomes neutral and finally alkaline in reaction in the lower part of the B horizon. None of the materials of the B horizon effervesces with acid, but the C horizon is alkaline and effervesces freely in cold dilute hydrochloric acid. Table 4 shows the range in pH values of a sample of virgin Russell silt loam taken in the NE. ¼ NE. ¼ sec. 21, T. 2 N., R. 4 E., near West Middletown, in Madison Township. Determinations were by the electrometric method, the hydrogen electrode being used.

TABLE 4.—*pH values of a sample of Russell silt loam*[1]

Horizon	Depth in inches	pH value	Horizon	Depth in inches	pH value
A_1	0- 3	6.57	B_2	24–40	7.33
A_2	3–12	6.00	C_1	40–50	8.35
B_1	12–24	5.52		144–168	8.09

[1] Determinations by E. H. Bailey, Bureau of Chemistry and Soils.

Variations in the depth of leaching, the degree of eluviation, and the thickness of the lower part of the B horizon, probably due to differences in the age of the parent glacial drift, have been made the bases of separating the mature well-drained upland soils of the county into the Russell, Miami, and Cincinnati soil series. These soils are all developed from similar glacial material deposited at different advances of the ice sheet. In most areas of Miami silt loam, in contrast with Russell silt loam, a greater proportion of the finer clay particles remains in the A horizon. Leaching of the carbonates has not been so thorough nor has it extended to so great a depth. However, the depth as recorded in the combined thickness of the A and B horizons, varies with the comparative rate of erosion and downward invasion into the C horizon at any particular location. The increased thickness of the B horizon in the Russell soils is in the lower part of the horizon. In the Miami soils the change is more abrupt from acid to neutral material and from the heavier upper B horizon to the friable calcareous C horizon. In the Miami soils as a rule the reddish tint is not so strongly pronounced in the B horizon.

Differences in the physical composition of the various layers of Miami silt loam and Russell silt loam are indicated in Tables 5 and 6, showing the results of mechanical analyses.

TABLE 5.—*Mechanical analyses of Miami silt loam* [1]

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
272923	Surface soil, 0 to 2 inches	0.8	2.4	3.4	6.8	4.4	58.8	23.4
272924	Subsurface soil, 2 to 10 inches	.6	1.7	3.5	7.0	4.9	56.4	25.8
272925	Subsoil, 10 to 18 inches	.6	1.6	3.3	7.0	4.8	47.0	35.7
272926	Subsoil, 18 to 27 inches	1.3	3.5	6.1	12.2	9.3	24.8	42.8
272927	Substratum, 27 to 36 inches	4.9	6.8	7.1	12.9	11.3	32.4	24.4

[1] After treatment with hydrogen peroxide.

TABLE 6.—*Mechanical analyses of Russell silt loam* [1]

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
2729145	Surface soil, 0 to 3 inches	0.7	2.6	3.5	6.8	5.2	60.2	20.9
2729146	Subsurface soil, 3 to 12 inches	.3	1.6	2.7	5.2	3.9	61.0	25.3
2729147	Subsoil, 12 to 24 inches	1.4	2.3	4.0	8.6	7.1	31.0	45.7
2729148	Subsoil, 24 to 40 inches	1.1	2.8	4.9	11.1	8.8	25.6	45.8
2729149	Substratum, 40 to 50 inches	4.5	6.8	7.0	13.1	10.8	35.1	22.8
2729150	Substratum, 12 to 14 feet	4.7	5.9	6.7	12.8	10.6	34.0	25.3

[1] After treatment with hydrogen peroxide.

On the other extreme Cincinnati silt loam, in contrast with Russell silt loam, has in general a lower content of the finer clay particles in both the A and B horizons and is more thoroughly leached of carbonates. The leaching has extended to a greater depth and in many places the readily soluble carbonates have been removed from the soil material down to bedrock. The reddish tint is uniformly more strongly pronounced than in the Russell soils. The combined thickness of the layers from the top of the normal B horizon to the parent material is, as a rule, from 2 to 4 or more feet greater than in the Russell soils. Chemical analyses may indicate other differences not readily detected by field observations.

Falling in this same group of upland soils are members of the Fincastle and Rossmoyne series. The Fincastle soils are associated with the Russell and the Rossmoyne with the Cincinnati. These soils are separated from the well-drained soils with which they are associated because of differences in physical characteristics brought about by poorer surface and internal drainage, indicated by a predominance of lighter colors (grays and yellows) and also by a definite mottling of gray, especially in the lower part of the A and in the B horizons. Soils of this group occupy the smooth gently undulating parts of the interstream areas. In places poorly drained flats occur in the interiors of these areas, and here the gray colors are still more pronounced, and segregation of the iron into concretionary pebbles has continued until large numbers of them occur on the surface and through the soil mass.

The Delmar and Clermont soils occur on the flats within areas of Fincastle and Rossmoyne soils, the Delmar in association with the Fincastle and the Clermont with the Rossmoyne. They are still further removed than the Fincastle and Rossmoyne soils from the normally developed soils in physical characteristics, are more strongly acid, and have less definitely developed texture and color profiles. In the Clermont soils the higher proportion of silt continues to a depth of 3 to more than 4 feet in some places, though, as a rule, a heavier layer lies at an average depth of 24 inches. A dark-gray heavy layer lying at a depth of about 36 inches and extending downward for about 3 feet forms a very striking feature of the Clermont silt loam profile. A definite columnar structure has developed in this layer, with the columns reaching upward and the gray silty layer above capping them. Analysis of this layer shows a comparatively high percentage of manganese in comparison with the layers above and beneath it.[6]

The profiles of the Fox, Bellefontaine, and Shandon soils resemble the regional profile very closely in the major characteristics of the A and B horizons and differ from it primarily in the character of the parent material which consists chiefly of water-laid material containing considerable lime. In the Fox and Bellefontaine soils loose more or less assorted and stratified beds of calcareous gravel and sand form the substratum. The Shandon soils are underlain by loose sands which in turn rest on calcareous slack-water clay. The excellent underdrainage has accelerated the action of soil-forming forces to such a degree that brown silty surface layers and comparatively heavy brown or reddish-brown subsoils have developed.

Many soils in the county have developed profiles differing very widely from the normal regional profile. They fall into three principal groups, as follows: (1) Those which have been restricted in development by high water tables, as the Brookston, Clyde, and Montgomery soils; (2) those which have been restricted or changed by rapid erosion, as Russell silt loam, eroded phase, and the Fairmount soils; and (3) those which have been restricted in development by reason of their comparatively recent deposition, such as the Genesee, Ross, and Eel soils.

The following profile description of Montgomery silty clay loam describes the major characteristics of all the soils of the first group, except in the parent-material layer: (1) From 0 to 5 inches, very dark brownish-gray silty clay loam, sticky and plastic when wet and very dark grayish brown when dry and pulverized. Air-dry lumps are too firm to crush by direct hand pressure. The pH value is 6.5. (2) From 5 to 14 inches, very dark brownish-gray silty clay, very sticky, waxy, and plastic when moist but very hard and brittle when dry, breaking in the hand only with a strong shearing force. Broken fragments are angular and their maximum diameter is three-fourths inch. Scattered fine pores occur in places, but the larger part of the mass is dense. Brown specks occur throughout, and a cut surface is streaked with dark-brown and yellow stains. Air-dry lumps are very dark gray with yellow and brown specks. A cut surface of the dry fragments is gray and shiny. The pH value is

[6] CONREY, G. W. A STUDY OF THE PROFILE OF CLERMONT SILT LOAM. Amer. Soil Survey Assoc. Bul. 8: 1–8. 1927. [Mimeographed.]

7.02. (3) From 14 to 24 inches, very dark-gray, yellow, dark-brown, or yellowish-brown silty clay in which the dark shades predominate. The material is very sticky and plastic when moist but very hard and firm when air-dry. It is crushed in the hand only with a prying force. The general appearance is massive, and the material breaks into lumps of irregular size and shape. The pH value is 7.37. (4) From 24 to 56 inches, dark-gray clay throughout which are many yellow and yellowish-brown fine spots, giving a decided yellow or yellow-brown cast to the layer. Dark-brown concretionary fragments are scattered through the mass, which dries to a light-gray color with many yellow, brown, and dark-brown stains. When moist, the material is sticky and plastic but not so tough as the second layer. Broken lumps, which are irregular in size and shape, dry to a very hard condition but can be broken in the hand by using a shearing force. The pH value is 7.42. (5) From 56 to more than 63 inches, brown calcareous clay with bluish-gray seams. Scattered nodular lime concretions and, in places, a fine lamination of the particles occur. This layer breaks into more or less angular or curved-faced fragments with a maximum diameter of 2 inches. When dry, the material is very hard, firm, and resistant to crushing and breaking except by striking with a hard tool. The pH value is 7.93. This material is apparently a deposit laid down in quiet water, such as backwater above a dam.

The Brookston and Clyde soils are similar in their development to the Montgomery, except that they have developed from gravelly calcareous glacial till. The Clyde material has been wetter throughout its development than the Brookston, and the yellow and yellowish-brown colors are less pronounced and a bluish-gray color predominates to a depth ranging from 3 to 4 feet.

In the second group of imperfectly developed soils, erosion has been rapid and has either removed all or parts of the layers or so restricted their development that they retain many characteristics of the parent material. In the Fairmount soils the influence of glacial material is expressed by foreign pebbles, but residual clays from underlying limestones and shales make up the lower layers of these soils. Leaching of carbonates has been slow, and illuviation and eluviation have progressed to only a small extent.

The third group includes alluvial deposits along the streams. As these have been exposed to the action of soil-forming agencies for only comparatively brief periods, the layers which comprise them are primarily the result of variations in the sediments as they were deposited. The carbonates have not been removed or the texture particles disturbed greatly since deposition of the original material. The Genesee soils are characterized by grayish-brown surface layers ranging from silt loam to sand in texture and underlain, in most places within 40 inches from the surface, by loose incoherent layers of sand and gravelly sand. The Ross soils are very similar to the Genesee, except that they have very dark grayish-brown surface layers extending to a depth ranging from 16 to 39 or more inches. The Eel soils are characterized by dark-brown surface layers of silty clay loam, underlain by bluish-gray iron-stained materials which have been water-logged during long periods.

The soils of the county, when grouped according to the kind of materials from which they are derived, fall into three broad groups.

as follows: (1) Soils derived from glacial till; (2) soils derived chiefly from bedrock with a small admixture in places of glacial drift; and (3) soils derived from water-laid materials.

The first group may be divided into three subgroups, the first including the Russell, Fincastle, Delmar, Brookston, and Clyde soils underlain by glacial till of the Early Wisconsin age, the second consisting of the Miami soils having a parent material consisting of glacial till of the Late Wisconsin age, and the third including the Cincinnati, Rossmoyne, and Clermont soils derived from glacial till of the Illinoian age.

In the second broad group, consisting of those soils derived from bedrock with a small admixture of glacial materials, are the Fairmount soils.

The third group may be divided into three subgroups, the first including the Fox, Warsaw, and Westland soils derived from alluvial deposits of calcareous, distinctly stratified gravel, the second the Bellefontaine soils derived from poorly assorted calcareous sands and gravel under good or excessive drainage, and the third the Genesee, Ross, and Eel soils with characteristics depending primarily on the succession of stream deposits which compose them.

SUMMARY

Butler County is in the southwestern part of Ohio, in the second tier of counties north of the Ohio River. The Indiana State line forms the western county boundary. The total area is 466 square miles.

The land surface of the county is predominantly rolling though the greater part is not too steep for agricultural utilization. Surface drainage is in general good, being dominated by Miami River and its tributaries.

The climate is favorable for a variety of agricultural pursuits. The rainfall is well distributed, and the frost-free season averages 172 days.

Hamilton, the county seat, and Middletown are important industrial centers and marketing points for agricultural products. Cincinnati and Dayton are both excellent outside markets.

The county is well served by both railroads and highways. All the main public highways are paved. Electric power and light, telephones, and radios are common in many of the rural districts.

Most of the soils of Butler County are moderately well drained and have light-colored silty surface layers underlain by brownish heavy clayey layers. The Russell and Fincastle soils, which constitute most of the farm land, have these major characteristics. These soils are desirable for the production of corn, wheat, clover, and oats, and in places alfalfa does well. The Miami, Bellefontaine, Cincinnati, and Rossmoyne soils are other upland soils similar to the Russell and Fincastle but are of very small extent.

The Brookston and Clyde soils are dark-colored soils closely associated with the Russell and Fincastle. They are very fertile and produce well when properly drained. The Delmar and Clermont soils are naturally poorly drained and deficient in organic matter and available plant food.

The soils occupying the stream flood plains and the higher bench lands or terraces in the broad valleys are very fertile and in a high state of improvement. The Fox soils represent well-drained farm lands occupying the smooth high-lying benches along the major streams of the county. Associated with the Fox soils are soils of the Warsaw and Westland series. The flood-plain soils, mapped in the Genesee, Eel, and Ross series, are subject to overflow during extreme flood periods, but in general the surface run-off is rapid and the sandy texture of the substratum promotes internal drainage so that crops are produced practically every year with only occasional serious loss from floods.

Soils of another distinctive group, consisting of members of the Montgomery, McGary, and Shandon series, are important agriculturally but are very inextensive.

The Fairmount soils are fertile and productive of alfalfa, corn, and tobacco, but under cultivation they erode very rapidly. The eroded phase of Russell silt loam occupies eroded slopes of drainage ways which have invaded the region occupied by the Russell soils. Its chief value is for pasture and forestry.

Commercial fertilizers are used on wheat and tobacco, principally, and manure is utilized chiefly as a top-dressing on clover meadows. The clovers are important crops and most soils are well suited to their production, though a few, including the Clermont, Rossmoyne, Cincinnati, Delmar, and Fincastle, and part of the Fox are benefited by applications of lime. As a rule, the light-colored soils are deficient in available phosphorus.

The agriculture of the county consists chiefly of a combination of general farming and livestock raising. Corn, wheat, and clover are the important agricultural crops and are rather generally grown in a 3-year crop rotation. Alfalfa, timothy, and sweetclover are also grown. Alfalfa and sweetclover are rapidly gaining in favor as extensive areas are admirably suited to their production. Wheat is the chief cash crop, though tobacco and potatoes are grown to a small extent for cash. Dairying is the principal livestock industry, but hog raising is also important and is practiced successfully in connection with general farming and dairying.

○

[PUBLIC RESOLUTION—No. 9]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils, and on July 1, 1927, the Bureau of Soils became a unit of the Bureau of Chemistry and Soils.]

Areas surveyed in Ohio, shown by shading

U. S. GOVERNMENT PRINTING OFFICE: 1931

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HENRY G. KNIGHT, CHIEF
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CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP
BUTLER COUNTY
OHIO

OHIO AGRICULTURAL EXPERIMENT STATION
C. G. WILLIAMS, DIRECTOR
R. M. SALTER, CHIEF, DEPARTMENT OF AGRONOMY
G. W. CONREY, IN CHARGE SOIL SURVEY

CONVENTIONAL SIGNS

CULTURE
(Printed in black)

City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort

Secondary roads and Trails

Railroads Steam and Electric

Bridges, Ferry

R.R. Crossings, Tunnel

Ford, Dam

School or Church Cemeteries

Mine or Quarry Mine dumps Made land

Bluff, Escarpment, Rock outcrop and Triangulation station

Stony and Gravelly areas

Soil boundaries

Boundary lines

Boundary lines

Boundary lines

U.S. township and section lines

RELIEF
(Printed in brown or black)

Contours Depression contours

Prominent Hills Mountain Peaks

Sand Wash and Sand dunes

Shore and Low-water line, Sandbar

DRAINAGE
(Printed in blue)

Streams

Lakes, Ponds, Intermittent lakes

Intermittent streams

Springs, Canals and Ditches, Flumes

Swamp Salt marshes

Submerged marsh Tidal flats

The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.

LEGEND

Bellefontaine fine sandy loam — Bf	Fincastle silt loam — Fm
Bellefontaine silt loam — Bs	Genesee fine sand — Gd
Brookston silt loam — Bl	Genesee sandy loam — Gy
Cincinnati silt loam — Cs	Genesee fine sandy loam — Gf
Clermont silt loam — Co	Genesee silt loam — G
Clyde silty clay loam — Cc	McGary silt loam — Mm
Delmar silt loam — Ds	Mm — Gravelly substratum phase
Eel silty clay loam — Es	Miami silt loam — Ms
Fairmount silt loam — Fa	Montgomery silty clay loam — Mc
Fairmount silty clay loam — Fc	Ross silt loam — Ro
Fox sandy loam — Fy	Rossmoyne silt loam — Rl
Fox fine sandy loam — Ff	Russell silt loam — Rs
Fox gravelly loam — Fg	Rs — Eroded phase
Fg — Dark-colored phase	Shandon fine sandy loam — Sf
Fox silt loam — Fs	Warsaw loam — Wl
Fs — Deep phase	Warsaw silt loam, Deep phase — Ws
Fs — Dark-colored phase	Westland loam — Wm
	River wash — Rv

Mark Baldwin, Inspector, District 1
Soils surveyed by Earl D. Fowler, U. S. Department of Agriculture, in charge, and T. C. Green, Ohio Agricultural Experiment Station.

BASE MAP FROM
U. S. GEOLOGICAL SURVEY SHEETS

Scale 1/250,000
1 0 1 2 3 4 Miles
1 0 1 2 3 4 5 Kilometers
Contour interval 20 feet.
Datum is mean sea level.

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Field Operations
Bureau of Chemistry and Soils
1927